CA2ONAF 6- B479 ENG

a31188005432121b

NON CIRCULATING

NON-CIRCULATING

NOV 9 1953
Guelph Ont
Director of Research

BULLETINS

Nos. 479 to 494

Issued by the Ontario Department of Agriculture
Parliament Buildings, Toronto, Canada

ONTARIO

TORONTO
Printed and Published by Baptist Johnston, Printer to the Queen's Most Excellent Majesty
1953

Digitized by the Internet Archive
in 2011 with funding from
University of Guelph

http://www.archive.org/details/bulletinsfromon479494onta

BULLETINS

ISSUED BY

Ontario Department of Agriculture

Nos. 479 to 494

479—Supper Dishes	The Women's Institute Branch and Home Economics Service
480—Trees, Fruits and Grapes for the Home Garden	W. H. Upshall
481—Common Grain Smuts and Their Control	D. R. Sands
482—Family Farm Business Arrangements in Ontario	H. K. Leckie
483—Pruning Ornamental Trees, Shrubs and Vines	J. A. Weall and J. S. Shoemaker
484—A Guide to the Production of High Quality Milk	F. W. Hamilton
485—Growing Vegetable Transplants	T. H. Jones and J. S. Shoemaker
486—Onions	C. C. Filman and J. S. Shoemaker
487—The Grape in Ontario	O. A. Bradt
488—Exhibiting and Judging Vegetables	T. H. Jones and J. S. Shoemaker
489—Exhibiting and Judging Fruit	B. J. E. Teskey and J. S. Shoemaker
490—Beekeeping in Ontario for Honey Production and Pollination	A. N. L. Butler and E. A. Kerr
491—Tomatoes for Processing	L. R. Webber, F. F. Morwick T. J. Heeg and N. J. Thomas
492—Ontario Soils—Their Use, Management and Improvement	N. R. Richards
493—Dairy Husbandry in Ontario	
494—Nut Culture in Ontario	W. J. Strong

Supper Dishes

ONTARIO DEPARTMENT OF AGRICULTURE

STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO. BULLETIN 479. JUNE 1951

Supper Dishes

Table of Contents

CANADA'S FOOD RULES - - - - - - - - - - PAGE 3
OUR DAILY MEALS - - - - - - - - - - - PAGE 4
MEALS FOR A DAY - - - - - - - - - - - PAGE 5
SUPPER MENUS - - - - - - - - - - - - PAGE 5
SOUPS - - - - - - - - - - - - - - PAGE 7
MAIN DISHES - - - - - - - - - - - - - PAGE 11
VEGETABLES - - - - - - - - - - - - - PAGE 17
SALADS - - - - - - - - - - - - - - PAGE 19
DESSERTS - - - - - - - - - - - - - PAGE 23

THIS bulletin was prepared by the Nutrition Section of the Women's Institute Branch and Home Economics Service, Ontario Department of Agriculture. It has been approved by the Ontario Interdepartmental Nutrition Committee. All recipes in this bulletin have been tested and approved. You will find the recipe for Cheese Souffle, photographed on the front cover, on page 12.

MEASUREMENT ABBREVIATIONS

cup	c.
teaspoon	tsp.
tablespoon	tbsp.
ounce	oz.
pound	lb.
few grains	f.g.

MEASUREMENTS

3 tsp.	1 tbsp.
16 tbsp.	1 c.
1 c.	8 oz.

OVEN TEMPERATURES

Slow oven	250°-350°
Moderate oven	350°-400°
Hot oven	400°-450°
Very hot oven	450°-550°

Supper Dishes

HAVE you planned supper for to-night? Or would you welcome a suggestion? We all have a few tried and true dishes that we turn out with speed born of long practice. Once in a while, however, we wish for something different. We let our imagination roam among the exotic dishes in the magazines and cook book pictures. But, supper time is nearly here. We must be practical and produce something that everyone will like.

We bring you our favourite recipes: some old, some new. Some are quick; others require a little preparation beforehand. Planning makes them all easy.

Guide to Good Food

BEFORE planning, let's review Canada's Food Rules. We use Canada's Food Rules as a guide for planning good meals. The Rules show us the foods to include in three square meals each day. Eating is a pleasure when we can choose from foods like these.

Canada's Food Rules

1. MILK

Children (up to about 12 years): at least 1 pint.
Adolescents: at least 1½ pints.
Adults: at least ½ pint.

2. FRUIT

One serving of citrus fruit or tomatoes or their juices; and one serving of other fruit.

3. VEGETABLES

At least one serving of potatoes; and at least two servings of other vegetables, preferably leafy, green or yellow and frequently raw.

4. CEREALS AND BREAD

One serving of whole grain cereal, and at least four slices of bread (with butter or fortified margarine).

5. MEAT AND FISH

One serving of meat, fish, poultry, or meat alternates such as dried beans, eggs and cheese.
Use LIVER frequently.

In addition:

EGGS AND CHEESE

At least three times a week each.

VITAMIN D

At least 400 International Units daily for all growing persons and expectant and nursing mothers.

Approved by the Canadian Council on Nutrition, 1949.

Our Daily Meals

Our really smart planner will sit down and plan in advance; not just one meal at a time, but one day's meals. Then our planner can check with Canada's Food Rules (page 3) to see that all the recommended foods have been included. After these foods have been worked in, then we may include any extras. But do keep the sweet foods few and far between. Sweets offer little in the way of food value.

Let's check our daily meal plans to see that every member of the family will get his share of important foods. Will our teenager receive at least 1½ pints of milk every day? Will mother and father be sure to take at least ½ pint? Do we all eat lots of cheese? Remember that every one needs a serving of citrus fruit or tomatoes during the day. Don't confine these important foods to the young children. The others should be included too. When do the children and growing teenagers take the vitamin D preparation needed for good strong bones and teeth? Many make this a breakfast routine. A plan offers means of checking all these points. We can make certain that nothing is overlooked.

Plan meals with eye appeal

An attractive plate makes our mouth water on sight. Who can wait for the dinner bell? Foods can be colourful so remember to use them to their best advantage. Arrange red tomatoes and bright green beans with brown roast beef and white potatoes. Keep strictly away from such monotonous colourless combinations as mashed potatoes and white fish fillets. We can err on the other side too. Red tomatoes and purply beets do not go together. Separate them.

Plan contrast in textures

Meal planning includes planning for variety, and variety in textures is very important to good eating. Dry, crisp foods contrast delightfully with moist, soft foods. Creamed chicken with crisp toast and green crunchy salad makes a more appetizing supper dish than creamed chicken and mashed potatoes.

Plan contrast in temperature

The contrast here need not be on the same plate but can be supplied in the form of dessert or starter, whatever you prefer. We all like something hot at every meal, even on those July days. Remember for future reference, when serving a cold supper.

Plan contrast in flavour

A good meal has variety in flavours, too. Well-planned meals usually include both bland and distinctive flavours.

Plan for variety

Plan not only variety in the meal but variety from day to day, from week to week. Repetition may be fine in accomplishing some things but not when planning good meals.

Plan wise use of equipment

Make the most of your equipment. Experience a new high in efficiency and good meals.

Meals for a Day

We give you a few supper menus that have been planned with one eye on the Food Rules, (page 3), and the other on the recipes in this booklet. The foods listed that are not included in the recipes are very simple. We are sure you do not need a recipe for them anyway.

A new dish goes over better if flanked by family favourites. The unfamiliar is aided to popularity by the presence of the well-liked familiar. Before we know it, the new dish becomes a "family favourite". Time to try another new recipe!

Perhaps you will notice that the individual menus do not include all the foods shown in Canada's Food Rules. It is for this very reason we recommend planning the whole day's meals at one time. Then we can easily include all the foods we need. Here's how.

Breakfast

Orange or Grapefruit Juice
Raisin Oatmeal with Milk
Soft-cooked Egg
Whole Wheat Toast, Marmalade
Milk and Coffee

Dinner

Roast Beef, Gravy
Pan Roast Potatoes, Spinach
Whole Wheat Bread
Canned Peaches, Cookies
Milk and Tea

Supper

Cream of Tomato Soup (page 7)
Corn Bake (p. 11) with Bacon Strips
Cabbage and Apple Salad (page 20)
Whole Wheat Bread
Frozen Fruit Tarts (page 24)
Milk and Tea

SUPPER MENUS

Vegetable Chowder (p. 7)
Creamy Scrambled Eggs (p. 15)
Cole Slaw
Half Grapefruit
Cheesed Biscuits (p. 24)*

Cream Spinach Soup (p. 7)
Kidney Bean Salad (p. 21)
Whole Wheat Toast
Fruit Crisp (p. 24)
Cookies*

Baked Chicken (p. 13)
Baked Potatoes
Green Beans
Raw Carrot and Celery Strips
Frozen Strawberries
Cream Cheese Whip (p. 24)*

Beef Loaf Cups
Piquante Sauce (p. 13)
Baked Potatoes
Baked Carrot Strips and
Onion Rings
Quick Rice Pudding (p. 23)*

Mushroom Swiss Steak (p. 13)
Boiled Potatoes in Jackets
Cabbage and Fruit Salad (p. 20)
Baked Custard with
Caramel Sauce (p. 23)*

Baked Fish Fillets (p. 14)
Baked Acorn Squash
Tossed Green Salad (p. 20)
Lemon Pudding (p. 24)
Lemon Sauce (p. 24)*

Note: * Plan to serve whole wheat bread and offer milk to drink with these meals. Adults can form the habit of drinking milk with the main course, and tea or coffee with their dessert. It's easy to drink lots of milk this way.

For added enjoyment, serve hot cream soup. See recipe, page 7.

Soups

Soups have a great appeal for the supper meal, whether the day is hot or cold. Soup made with milk proves a satisfying dish that adds food value to our well-planned meal. Milk is a versatile food. It loses little or no food value in cooking. We may use it in cooking and as a beverage. Both young and old need the calcium liberally supplied by milk.

As well as calcium, milk offers us riboflavin, one of the B vitamins. Milk supplies about half of all the riboflavin in our Canadian diet. Milk provides good quality protein, found also in meat, eggs and fish. And to add to this list, milk includes other minerals and vitamins.

When we serve our families dishes made with milk, we are really serving them a feast of food value. Take your choice of these creamy soup or chowder recipes, welcome additions no matter what the weather.

Basic Cream Soup

2 c. scalded milk
2 c. sieved vegetable & juice
2 tbsp. flour
4 tbsp. butter
1 tsp. salt
additional seasonings, as desired

Note:

1. Some vegetables thicken more than others. When vegetables such as potatoes and squash are used, reduce the flour one-half.

2. Soak dried vegetables overnight before cooking.

3. In making Cream of Tomato Soup, use 2 c. tomato juice or sieved tomatoes in place of 2 c. sieved vegetable stock. Heat tomato just before adding to hot white sauce. Stir the tomato slowly in the white sauce.

1. *Any fresh, canned or dried vegetable may be used.*
2. *To prepare 2 c. sieved vegetable and juice use:*
   (a) 2 c. raw vegetable, cut in small pieces, or if leafy, packed down.
   (b) 1½ c. vegetables which pack closely, as peas, corn and parsnips.
   (c) ½ c. dried vegetables.
3. *Cook vegetables in boiling water until tender and press through sieve. There should be 2 c. sieved vegetable and stock. If there is too much stock, drain before sieving. If too little, add water to make 2 c.*
4. *Cream flour, butter and salt together in a bowl. Add to milk in double boiler. Cook and stir until smooth.*
5. *Add sieved vegetables and stock. Keep hot over boiling water. Serves 5.*

Vegetable cream soups may be made with any of these vegetables:

cabbage
carrot
cauliflower
celery
corn
green bean
lettuce
lima bean
mushroom
onion
parsnip
potato
pea
spinach
squash
tomato

Vegetable Chowder

2 c. scalded milk
2 c. corn, canned or fresh
2 c. celery, diced
¾ c. onion, sliced
3 tsp. salt
⅛ tsp. pepper
2½ c. cold water
½ green pepper, diced
1 c. tomatoes, canned or fresh
3 tbsp. flour
¼ c. fat
½ c. cheese, grated
¼ tsp. paprika

1. *Add corn, celery, onion, salt and pepper to cold water.*
2. *Cover, bring to boil and simmer 25 minutes.*
3. *Add tomatoes and green pepper and simmer 5 minutes longer.*
4. *Cream flour and fat together in a bowl. Add to scalded milk. Cook and stir until smooth.*
5. *Add to vegetable mixture.*
6. *Add cheese and paprika. Stir until cheese is melted. Or sprinkle cheese over soup in serving bowls. Serves 6-8.*

Cream of Onion and Cheese Soup

2 tbsp. fat
1 c. onions, sliced
1 tbsp. flour
2 c. milk
¾ tsp. salt
f.g. pepper
½ c. cheese, grated

1. *Melt fat in top of double boiler over direct heat.*
2. *Add sliced onions. Cook over low heat, stirring occasionally until almost tender (about 5 minutes).*
3. *Place over hot water in bottom of double boiler. Stir in flour and blend well.*
4. *Add milk gradually, then cook, stirring until thickened.*
5. *Add salt, pepper and cheese. Garnish with chopped parsley if desired. Serves 3-4.*

Cheese Soup

4 c. scalded milk
3 slices onion
2 tbsp. flour
1 tbsp. fat
½ tsp. salt
f.g. pepper
¾ c. processed cheese, grated

1. *Scald milk and onion in top of double boiler.*
2. *Cream flour, fat, salt and pepper together in a bowl.*
3. *Remove onion slices. Add fat mixture to scalded milk. Stir until smooth.*
4. *Add grated cheese. Stir until melted and blended into sauce. Serves 5-6.*

Carrot Potato Chowder

2 c. scalded milk
1 onion, sliced
¼ c. fat
2 c. potatoes, diced
1 c. carrots, diced
2 c. boiling water
1 tsp. salt
¼ tsp. paprika
1 tbsp. flour

1. *Brown onion in 2 tbsp. fat.*
2. *Add potatoes, carrots, boiling water, salt and paprika.*
3. *Boil 15 minutes, covered or until potatoes and carrots are tender.*
4. *Cream flour and remaining 2 tbsp. fat together in bowl. Add to milk in double boiler. Cook and stir until smooth.*
5. *Combine sauce with vegetable mixture. Serves 4-6.*

Ham Chowder

4 c. scalded milk
2 onions, diced
3 tbsp. fat
6 potatoes, diced
1 c. boiling water
2 tsp. salt
¼ tsp. pepper
1 tsp. Worcestershire sauce
¼ tsp. thyme
¼ tsp. paprika
2 c. peas, cooked
1 c. cooked ham, diced

1. *Cook onions in fat.*
2. *Add potatoes, boiling water and seasonings and cook for 15 minutes.*
3. *Add scalded milk, peas and ham.*
4. *Simmer 15 to 20 minutes.*

Corn and Chicken Chowder

2 tbsp. fat
½ c. onion, diced
1 c. potatoes, diced
1 c. chicken broth
1 c. cooked chicken, diced
1 c. kernel corn
2 tsp. salt
f.g. pepper
3 c. milk
½ tsp. Worcestershire sauce
2 tbsp. parsley, chopped

1. *Melt fat; add onion and cook until yellow.*
2. *Add potato and chicken broth and cook covered until potato is done, 10 to 15 minutes.*
3. *Add remaining ingredients and heat to boiling point. Serves 6.*

Quick Potato Soup

1½ c. potatoes, diced
3 tbsp. onion, diced
1 tbsp. fat
¾ c. boiling water
2 c. milk
¾ tsp. salt
f.g. pepper

1. *Cook potatoes, onion and fat in water until potatoes are tender.*
2. *Add milk, salt and pepper. Heat until almost boiling. Serves 4-5.*

Split Pea Soup

2 c. scalded milk
1 c. split peas
6 c. water
1 onion, diced
1 oz. salt pork, diced OR
3 slices bacon, diced
2 tbsp. flour
2 tbsp. fat
½ tsp. salt
f.g. pepper

1. *Wash peas, add water and boil for 2 minutes. Remove from heat and let soak 1 hour.*
2. *Cook peas, with onion and salt pork in soaking water 8 to 10 minutes, by 15 lb. pressure, or 1½ to 2 hours by simmering. If bacon is used, first brown with onion, then add to soup mixture.*
3. *Cream flour and fat.*
4. *Add to hot mixture, stir until thickened.*
5. *Add milk. Season. Serves 6.*

Navy Bean Soup

scalded milk
1 c. navy beans
4 c. water
1 tsp. salt
f.g. pepper
¼ c. onion, diced
½ c. celery, diced
1 bay leaf (optional)
1 ham bone (optional)

1. *Wash beans, add water and boil for 2 minutes. Remove from heat and let soak 1 hour.*
2. *Cook all ingredients, except milk, 45 minutes, by 15 lb. pressure, or 2 hours by simmering.*
3. *Press mixture through sieve and thin to desired consistency with milk. Serves 4-6.*

Old Fashioned Vegetable Soup

2 lb. brisket
½ c. pearl barley
1 c. navy beans
2 qt. water
½ c. onion, sliced
½ c. turnip, diced
1½ c. cabbage, shredded
1 c. tomatoes
1 c. celery, diced
2 tsp. salt
f.g. pepper

1. *Put brisket, barley and beans in cold water and bring slowly to simmering point. Skim if necessary.*
2. *Simmer 2 hours.*
3. *Add vegetables and simmer ½ hour.*
4. *Season. Serves 8-12.*

Mother's Special Soup

1 lb. beef chuck, cut in 1″ cubes
3 tbsp. fat
2 onions, sliced
1 tsp. pepper
2 tbsp. salt
1 lb. marrow bone, cracked
1-28 oz. tin or 3¼c. cooked tomatoes
6 c. cold water
1 quartered apple, cored, pared
¼ c. lemon juice
2 tbsp. brown sugar
6 c. cabbage, shredded
4-6 potatoes, quartered

1. *Brown meat in fat.*
2. *Add onions and brown lightly.*
3. *Add pepper, salt, bone, tomatoes, cold water and apple.*
4. *Cover, bring to boil and simmer 2 hours.*
5. *When meat is tender, add lemon juice, brown sugar, cabbage and potatoes. Cook covered 30 minutes.*

Clear Tomato Soup

2 c. tomatoes
2 c. water
12 pepper berries
4 cloves
1 bay leaf
1 onion slice
2 tsp. sugar
3 tbsp. flour
2 tbsp. fat
1 tsp. salt

1. *Combine first seven ingredients and cook 10 minutes. Press mixture through a sieve.*
2. *Cream flour, fat and salt together in bowl. Add to tomato mixture. Cook and stir until smooth. Serves 4-5.*

Garnishes for Soups

salted whipped cream
grated cheese
bread croutons or toasted diced bread
chopped parsley, chives or green onions

Try this vegetable shortcake for a change. See recipe, page 13.

Main Dishes

A WIDE variety of supper dishes is ours if we take the time to plan ahead. In addition we suggest a few dishes that can be prepared in a twinkling provided you keep your emergency shelf stocked.

The casserole can be used again and again. Usually casserole mixtures are quickly prepared but remember they do take time to cook in the oven. That is where planning ahead enters into the picture. We do need to bestir ourselves a few minutes before the meal is ready to be placed on the table.

Many of these casseroles have white sauce for a base. A few suggestions on our part will spur you on to devise favourite combinations of your own that will please your family.

Cheese substitutes for meat in many main dishes in this booklet. Because cheese is a concentrated food, we suggest serving it with bulky foods such as leafy green vegetables and fruits. There are many types of cheese on the market in Ontario. Branch out and try something different for a change. Tickle that palate of yours with a new taste sensation. But of course our real standby is Canadian Cheddar. This, too, you can buy to suit your fancy, mild, medium or strong depending on its age. Processed cheese is usually made from a Cheddar base. Several lots of cheese are blended to produce the desired product. Remember that cheese cookery calls for low temperatures to melt cheese gently. High temperatures or overcooking means tough, stringy cheese, oozing oil.

White Sauce Mix

1 c. flour
1 c. butter

1. Blend flour and butter to a smooth paste. Keep covered in cold place.

White Sauce

	Thin	***Medium***	***Thick***
scalded milk	*1 c.*	*1 c.*	*1 c.*
White Sauce Mix (above)	*1½ tbsp.*	*3 tbsp.*	*4½ tbsp.*
salt	*¼ tsp.*	*¼ tsp.*	*¼ tsp.*
pepper	*f.g.*	*f.g.*	*f.g.*

1. Add White Sauce Mix, salt and pepper to scalded milk. Cook and stir until smooth.

Simple Supper Dishes

To 1 c. White Sauce, add 1 c.-2 c. of any one or attractive combination of these cooked vegetables:

asparagus
broccoli
cabbage
carrots
cauliflower
celery
corn
green beans
lima beans
onions
peas
wax beans

Serve on toast. Or combine in greased casserole, top with buttered whole wheat bread crumbs, and finish in moderate oven, 350°, until brown and bubbly, 15-30 minutes.

Scalloped Corn Bake

2 c. whole kernel or cream style corn
½ c.-¾ c. milk
1 c. whole wheat bread crumbs
3 tbsp. onion, diced
3 tbsp. green pepper, diced
½ tsp. salt
f.g. pepper
2 tbsp. fat

1. *Combine in greased casserole, 1½ qt. size, whole kernel corn and ¾ c. milk, or cream style corn and ½ c. milk.*
2. *Add bread crumbs, onion, green pepper, salt and pepper. Dot with fat.*
3. *Bake in moderate oven, 350°, 30-40 minutes. Serves 6.*

Cheese Souffle

1 c. scalded milk
4 tbsp. flour
3 tbsp. fat
¼ tsp. salt
f.g. pepper
3 egg yolks, beaten
1 c. cheese, grated
3 egg whites beaten stiff but not dry

1. *Cream flour, fat and seasonings together in a bowl. Add to milk in double boiler. Cook and stir until thick and smooth.*
2. *Fold egg yolks into White Sauce, first adding a little of the sauce to the egg yolk and stirring thoroughly.*
3. *Add grated cheese. Remove from heat. Cool slightly.*
4. *Fold sauce into beaten egg whites. Pour into casserole, 1½ qt. size. Set casserole in pan of hot water (oven-poach).*
5. *Bake in slow oven, 350°, 1-1¼ hours until knife put into centre comes out clean. Serve at once. Serves 4-5.*

NOTE:

If desired, ⅛ tsp. cream of tartar may be added to the partially beaten egg whites. This helps prevent the souffle from falling so rapidly after removal from the oven.

Eggs and Green Beans au Gratin

3 c. scalded milk
2 tbsp. onion, diced
6 tbsp. flour
6 tbsp. fat
1 tsp. salt
f.g. pepper
6 eggs, hard-cooked
2 c. green beans, cooked or canned
½ c. whole wheat bread crumbs
½ c. cheese, grated

1. *Add onion to milk and scald in double boiler.*
2. *Cream flour, fat and seasonings together in a bowl. Add to milk. Cook and stir until smooth.*
3. *In greased casserole, 2 qt. size, place alternate layers of sliced egg, beans and sauce, using sauce for the top layer.*
4. *Top with mixture of bread crumbs and cheese.*
5. *Bake in moderate oven, 350°, 30 minutes. Serves 6.*

Kidney Bean Rarebit

¼ c. onion, diced
½ c. green pepper, diced
2 tbsp. fat
2 c. kidney beans, canned or home-cooked
2 tbsp. catsup
1 tsp. Worcestershire sauce
⅛ tsp. pepper
½ tsp. salt
½ lb. cheese, diced

1. *Brown onion and green pepper in fat.*
2. *Add beans, catsup, Worcestershire sauce, salt and pepper.*
3. *Alternate layers of bean mixture and cheese in greased casserole, 1½ qt. size.*
4. *Bake in slow oven, 325°, 20 minutes. Serves 5-6.*

Savoury Rice

2 tbsp. fat
4 tbsp. onion, diced
2 c. tomatoes
½ c. celery, diced
4 tbsp. green pepper, diced
2 c. cooked rice (½ c. raw)
¼ c. cheese, grated
½ c. whole wheat bread crumbs
1 tbsp. fat, melted

1. *Melt fat and cook onions until limp.*
2. *Add tomatoes, celery and green pepper and simmer 10 minutes.*
3. *Combine in greased casserole, 1½ qt. size, tomato mixture, rice and cheese.*
4. *Combine bread crumbs and melted fat and sprinkle over top of mixture.*
5. *Bake in moderate oven, 350°, 30 minutes. Serves 5-6.*

Beef Loaf

1 lb. beef, ground
1 tsp. salt
⅛ tsp. pepper
¼ c. onion, diced
1 egg, beaten
½ c. soft bread crumbs
1 10-oz. tin cream of mushroom soup
2 tbsp. green pepper, diced

1. *Combine beef, salt, pepper, onion, egg and bread crumbs. Mix gently and shape into loaf.*
2. *Place in greased baking dish or casserole, 1½ qt. size.*
3. *Combine soup and green pepper; pour over meat loaf.*
4. *Bake in moderate oven, 350°, 1 hour. Serves 4-5.*

Beef Loaf Cups

½ c. dry bread crumbs
½ c. milk
¾ lb. beef, ground
1 egg, slightly beaten
2 tbsp. onion, diced
½ tsp. salt
f.g. pepper
¼ tsp. sage

1. *Soak bread crumbs in milk in large bowl.*
2. *Add meat, eggs, onion, salt, pepper and sage. Mix well.*
3. *Place in greased muffin tins. With fork, press top down to form small cup.*
4. *Make Piquante Sauce (below) by mixing brown sugar, catsup or chili sauce, nutmeg and dry mustard. Place on top of meat.*
5. *Bake in moderate oven, 350°, 45 minutes. Serves 4.*

Piquante Sauce

3 tbsp. brown sugar
4 tbsp. catsup or chili sauce
¼ tsp. nutmeg
1 tsp. dry mustard

Pork or Veal Chops Baked in Milk

4 pork or veal chops
seasoned flour
fat
1 c.-1½ c. milk

1. *Dip chops in seasoned flour.*
2. *Brown chops in fat in pan.*
3. *Place chops in covered casserole, 1½ qt. size. Add enough milk to nearly cover the chops.*
4. *Bake in moderate oven, 350°, 1 hour. Serves 4.*

Mushroom Swiss Steak

1 lb.-1½ lb. round steak
2 tbsp. fat
½ c. milk
1, 10-oz tin cream of mushroom soup

1. *Brown steak slowly in fat.*
2. *Combine soup and milk. Add to steak.*
3. *Cover and bake in slow oven, 325°, 45-60 minutes. Serves 4.*

Baked Chicken

3 c. scalded milk
2 frying chickens (2 lb.-2½ lb. each)
seasoned flour
fat

1. *Cut chicken into serving pieces. Dip in seasoned flour.*
2. *Fry in fat until browned, keeping pan covered as much as possible.*
3. *Place chicken in deep casserole, cover with milk. Cover tightly and bake in slow oven, 325°, 30-35 minutes until tender.*
4. *Remove chicken and keep it hot. Make gravy in a pan using 3½ tbsp. flour and a little water to make a paste. Add milk and broth from casserole.*
5. *Season with salt and pepper and pour over chicken which has been put back in the casserole. Reheat. Serves 6-8.*

Vegetable Shortcake

½ lb. processed cheese
⅓ c. milk
1½ c. cooked vegetables
(carrots, peas, corn, green beans)

1. *Melt cheese in top of double boiler.*
2. *Gradually add milk, stir until smooth.*
3. *Add vegetables.*
4. *Split hot Tea Biscuits (below) and put together with filling of hot cheese and vegetable mixture.*

Tea Biscuits

2 c. sifted pastry flour
or
1 c. sifted pastry flour *and*
1 c. sifted whole wheat flour
4 tsp. baking powder
½ tsp. salt
⅓ c. fat
about ⅔ c. milk

1. *Sift dry ingredients into mixing bowl.*
2. *Cut in fat.*
3. *Pour milk into centre of flour mixture. Stir until mixture leaves sides of bowl.*
4. *Knead gently on lightly floured board, 1 minute. Pat to 1" thickness. Cut.*
5. *Bake on ungreased pan, in very hot oven, 450°-500°, 10-12 minutes. Serves 6.*

Salmon Souffle

1 c. scalded milk
4 tbsp. flour
3 tbsp. fat
¼ tsp. salt
f.g. pepper
1 c. salmon
¼ c. whole wheat bread crumbs
3 eggs, separated

1. *Cream flour, fat and seasonings together in a bowl. Add to milk in double boiler. Cook and stir until smooth.*
2. *To White Sauce, add flaked salmon (include mashed bones and juice) and whole wheat bread crumbs.*
3. *Add beaten egg yolks to the salmon mixture.*
4. *Fold in stiffly beaten egg whites. Bake in slow oven, 325°, 60-70 minutes. Serves 4-5.*

Baked Creamed Fish Fillets

2 lb. fish fillets (cod, sole, haddock, halibut) fresh or frozen
¼ tsp. salt
f.g. pepper
¼ tsp. paprika
juice of 1 lemon

1. *Cut fillets in serving pieces. Place in greased shallow baking dish.*
2. *Sprinkle with salt, pepper, paprika and lemon juice.*
3. *Make White Sauce (below): cream flour, fat and seasonings together in a bowl. Add to scalded milk. Cook and stir until thick and smooth.*
4. *Pour sauce over fillets. Cover with topping (below).*
5. *Bake in moderate oven, 350°, 35 minutes. Serves 6.*

White Sauce

1 c. scalded milk
2 tbsp. flour
2 tbsp. fat
¼ tsp. salt
f.g. pepper
1 tbsp. dry mustard

Topping

½ c. whole wheat bread crumbs
2 tbsp. fat, melted
1 tbsp. parsley, chopped

Scalloped Fish

1 lb. fish
¼ c. bread crumbs
1½ c. White Sauce
¼ tsp. mace
½ tsp. paprika

1. *Simmer fish in water until just tender and let cool in same water. When cold, take out all bones and break up fish into small pieces.*
2. *Put alternate layers of fish and seasoned White Sauce (see method page 11) in a greased casserole, 1½ qt. size. Cover with crumbs. Place in a hot oven, 400°, 20-30 minutes, until browned and bubbly. Serves 4.*

Welsh Rarebit

½ lb. cheese (2 c. grated)
⅓ c. milk
¼ tsp. dry mustard
¼ tsp. salt
1 tsp. Worcestershire sauce
f.g. cayenne pepper
1 egg, well beaten

1. *Melt cheese in top of double boiler.*
2. *Gradually add milk, stir until smooth.*
3. *Add seasonings.*
4. *Stir in egg and cook 1 minute.*
5. *Serve on toast. Serves 6.*

Cheese Fondue

2 c. brown bread cut in ⅔″ cubes
1 c. cheese, grated
2 eggs
2 c. milk
2 tbsp. fat, melted
1 tsp. salt
f.g. pepper

1. *Grease casserole, 1½ qt. size.*
2. *In it place cubes of bread and cheese in layers, ending with bread on top.*
3. *Beat eggs, add milk, fat and seasonings.*
4. *Pour mixture over bread. Allow to stand 20 minutes.*
5. *Place casserole in a pan of hot water and bake in moderate oven, 350°, 35-40 minutes. Serves 4-5.*

QUICKIES

Salmon and Mushroom

1,10 oz. tin cream of mushroom soup
1 c. salmon, flaked
toast

1. *Combine salmon and soup and heat in top of double boiler.*
2. *Serve on toast.*

Mushroom Rarebit

1,10 oz. tin cream of mushroom soup
½ c. milk
½ c. cheddar cheese, grated

1. *Combine all ingredients in top of double boiler.*
2. *Heat, stirring occasionally, until cheese is melted. Serve on toast. Serves 4.*

Cheese and Bacon Sandwich

butter
whole wheat bread
sliced cheddar cheese
bacon slices (cut in thirds)

1. *For each sandwich, butter one slice bread.*
2. *Spread buttered bread with cheese, then arrange slice of bacon, cut in thirds over cheese.*
3. *Place on rack under preheated broiler, 10 minutes or until cheese is bubbly and bacon done "as you like it".*

Cheese Dreams

For each serving, place slice of cheese between 2 slices of bread. Butter outside of both slices of bread. Brown lightly on both sides in frying pan over low heat.

Creamy Scrambled Eggs

4 eggs
¼ c. milk
½ tsp. salt
⅛ tsp. pepper
4 tsp. butter

1. *In top of double boiler, beat eggs until yolks are well mixed. Add milk, salt, pepper and butter.*
2. *Cook in double boiler over low heat, stirring occasionally until eggs are thick and creamy. Serve at once. Serves 2-4.*

Savoury Scrambled Eggs

Use recipe of Creamy Scrambled Eggs (opp.). Add 1 tbsp. onion, diced, 1-2 tbsp. parsley, chopped, 2 tbsp. green pepper, diced (optional).

Scrambled Eggs with Cheese

Use recipe of Creamy Scrambled Eggs (opp). Add ¼ c. cheddar cheese, grated or cubed, to the egg mixture.

Grilled Hamburger Sandwiches

6 slices bread
½ lb. beef, ground
½ tsp. salt
¼ tsp. pepper
¼ tsp. dry mustard
tomato juice to moisten

1. *Toast bread on one side.*
2. *Mix remaining ingredients and spread on untoasted side of bread.*
3. *Cook under broiling unit until meat is browned. Thin slices of tomato or onion or finely chopped green pepper may be placed on sandwiches, just before the meat is browned. Cook a few minutes longer.*

Cheeseburgers

Try this in your broiler. Top broiled hamburger patties with a thin slice of processed cheese. Return to broiler under the heat until the cheese is just melted. Serve at once.

Omelet

4 eggs
4 tbsp. milk
½ tsp. salt
f.g. pepper
2 tbsp. fat

1. *Beat eggs slightly, only enough to blend the yolks and whites.*
2. *Add milk and seasonings.*
3. *Add fat to frying pan and when melted add the egg mixture.*
4. *As omelet cooks, lift edges towards centre. When bottom is browned, fold omelet over and serve immediately. Serves 3-4.*

Creamed Eggs

6 eggs, hard-cooked
2 c. Medium White Sauce (page 11)

1. *Cut eggs lengthwise and heat gently in White Sauce. If desired, serve on toast. Serves 3-6.*

Well prepared vegetables look good and taste good. Serving a **variety** *of vegetables will add interest to your evening meals.*

Vegetables

"THE more delicious, the more nutritious", applies generally to vegetables. The better the taste, the more food value. Garden fresh vegetables, properly cooked, are more than good to eat. They are good for us. Overcooked vegetables lack flavour and food value.

A word to the wise. To save flavour and food value when boiling vegetables, it pays to heed these hints:

- Start cooking vegetables in boiling water.
- Use a small amount of cooking water and cover pan tightly to prevent scorching.
- Adjust heat to keep at a gentle rolling boil.
- Cook vegetables only until they are crisp-tender, not mushy.
- Serve vegetables as soon as they are cooked.
- Use cooking liquid.

Looking for an easy method for cooking vegetables? Try baking. You will be delighted with the flavour and remember "the more delicious, the more nutritious". Bake all vegetables, except potatoes, in a moderate oven, 350°. Potatoes are better baked in a hot oven, 425°. Do not bake longer than necessary. Serve at once.

Frozen vegetables are best popped frozen into a small amount of boiling water. Cover the pan and bring the water back to the boil as quickly as possible. However, corn-on-the-cob is thawed for several hours before cooking. Otherwise, you will find an icy cob on your hands. Frozen corn-on-the-cob should be cooked in enough boiling water to cover. All frozen vegetables cook more quickly than fresh vegetables. Do not overcook. Serve as soon as cooked.

Pressure cooking is another way to cook vegetables for flavour and food value. Follow the directions for your pressure cooker. A little experimenting on your part will help you determine proper cooking times. It is most important not to overcook because the high temperature will quickly destroy vitamins. Another point to remember, start the vegetables cooking in a heated pressure cooker. We save vitamins that are otherwise lost during the heating period.

Serve all vegetables as soon as cooked. They lose flavour and food value on standing. And for *goodness* sake, don't make a habit of cooking enough vegetables to reheat for another day. It may save time but you waste food value and flavour. Any water in which vegetables are cooked should be used in gravy and soup.

Here's a tempting salad bowl. Easy to prepare. See recipe, page 20.

Salads

SUPPER is often a good meal in which to include a salad. Salads are not only good for us, they are good to eat. A crunchy colourful salad is perfect with a steaming casserole dish. Most salads are easy to make. We like to prepare them just before the meal so that we keep all the food value in the fresh fruit and vegetables. Some raw fruit and vegetables are good sources of vitamin C. If salads made with fresh fruits or vegetables are prepared too far ahead of time, we lose some of that elusive vitamin C. A wilted salad is no longer appetizing and our families spurn such "rabbit food".

But picture a crisp salad of garden fresh vegetables: glistening red tomatoes, cool green cabbage, bright green pepper. Our own fresh-picked vegetables are packed with goodness and food value so let's use them while they are plentiful. We do not have to confine our "Salad Days" to summer and fall. There are many salads to serve in winter. Have you tried raw turnip as a salad vegetable? Or cheese and apples?

If you would like more salad recipes, write for the booklet "Salads—All the Year 'Round", Women's Institute Branch and Home Economics Service, Ontario Department of Agriculture, 1207 Bay St., Toronto 5, Ont.

French Dressing

4 tbsp. vinegar
6 tbsp. salad oil
¼ tsp. dry mustard
¼ tsp. salt
f.g. pepper
2 drops Tabasco sauce
1 peeled garlic clove

1. *Mix all ingredients together.*
2. *Remove garlic clove after several hours.*
3. *Store in covered container in cold place. Shake well before using.*

Mayonnaise

1 egg yolk
½ tsp.-1 tsp. salt
½ tsp. dry mustard
¼ tsp. paprika
f.g. cayenne pepper
2 tbsp. vinegar or lemon juice
1 c. salad oil

1. *Put egg yolk and seasonings into bowl and beat thoroughly with Dover egg beater.*
2. *Add 1 tbsp. vinegar or lemon juice and beat again.*
3. *Gradually beat in oil, adding ½ tsp. at a time until ¼ c. is used.*
4. *Then add 1 to 2 tbsp. at a time.*
5. *As mixture thickens, add remaining vinegar or lemon juice.*
6. *Store in covered container in cold place.*

Cooked Salad Dressing

1 tsp. dry mustard
1 tsp. salt
2 tbsp. sugar
2 tbsp. flour
2 egg yolks, beaten
1 c. milk
2 tbsp. fat
⅓ c. vinegar

1. *Mix mustard, salt, sugar and flour in top of double boiler.*
2. *Add beaten egg yolks and milk.*
3. *Cook over boiling water, stir until thickened.*
4. *Add fat.*
5. *Remove from heat. Cool.*
6. *Add vinegar slowly.*
7. *Store in covered container in cold place.*

Sour Cream Dressing

1 tsp. salt
3 tbsp. vinegar
¼ tsp. dry mustard
1 c. evaporated milk

1. *Mix salt, vinegar and mustard.*
2. *Stir slowly into milk.*

To make dressing for fruit: use 4 tbsp.-5 tbsp. lemon juice in place of vinegar. Season to taste. Store in covered container in cold place.

Cabbage and Vegetable Salad

2 c. cabbage, shredded
½ c.-1 c. raw vegetable, diced, sliced or grated
mayonnaise or French dressing or sour cream dressing

1. *Mix ingredients just before serving. Serves 4-5.*

Raw vegetables to use: carrot, celery, cucumber, green pepper, radish, spinach, tomato, turnip.

Cabbage and Fruit Salad

2 c. cabbage, shredded
½ c.-1 c. fruit, diced
mayonnaise or French dressing or sour cream dressing

1. *Mix ingredients just before serving. Serves 4-5.*

Use fresh, dried or canned fruit: apples, apricots, bananas, cocoanut, dates, grapefruit, oranges, peaches, pears, pineapple, raisins.

Cabbage and Cheese Salad

2 c. cabbage, shredded
½ c. cheese, grated, diced or crumbled
salt
mayonnaise or French dressing or sour cream dressing

1. *Mix ingredients just before serving. Serves 4-5.*

Vary the kinds of cheese you use: cheddar, processed, cottage, "blue", Swiss, Stilton.

Cabbage, Cucumber and Egg Salad

4 c. cabbage, shredded
1 c. cucumber, diced
2 green onions, sliced
3 hard-cooked eggs, chopped
salt
pepper
½ c. sour cream dressing

1. *Mix ingredients just before serving. Serves 6-8.*

Tossed Green Salad

2 c. lettuce, torn
1 c. endive (optional)
½ c. cucumber slices
1 c. tomato wedges
water cress
French dressing

NOTE:
See illustration, page 18.

1. *Prepare vegetables immediately before serving.*
2. *Serve with French dressing. Serves 5-6.*

Tossed Salad

1 onion, sliced
2 c. lettuce, torn
½ c. celery tops
½ c. celery, diced
½ c. raw carrot, grated
½ c. raw tomato, diced
½ c. raw parsnip, grated
¼ c. raw turnip, grated
¼ c. raw beet, grated
½ c. French dressing or
4 tbsp. lemon juice or vinegar

1. *Separate onion slices into rings.*
2. *Toss all ingredients lightly just before serving. Serves 6-8.*

Potato Salad

4 c. cooked potatoes, diced
½ c. onion, diced
1½ tsp. salt
⅛ tsp. pepper
1 c. celery, diced
2 hard-cooked eggs, diced
¼ c. parsley, chopped
mayonnaise or cooked salad dressing

1. *Cook and cool potatoes in their jackets. Remove skins and dice.*
2. *Combine ingredients. Chill. Serves 6.*

Cheese and Apple Salad

3 c. diced red apples, unpeeled
1 c. celery, diced
¾ c. cheese, diced
¼ tsp. salt
1 tbsp. lemon juice
½ c. mayonnaise
or cooked salad dressing

1. *Combine ingredients just before serving. Serves 6.*

Carrot and Cottage Cheese Salad

2 c. cottage cheese
¾ c. raw carrot, grated
¼ c. green pepper, diced (optional)
¼ c. mayonnaise

1. *Combine ingredients just before serving. Season. Serves 6-8.*

Whole Meal Salad

4 c. mixed salad greens
3 tomatoes, quartered
2 hard-cooked eggs, sliced or quartered
½ c. cooked ham, diced
1 c. cheddar cheese, diced or cut in strips
French dressing

1. *Break salad greens into bite size pieces.*
2. *Combine ingredients just before serving. Season. Serves 6.*

Ham and Pea Salad

1 c. cooked ham, diced
½ c. celery, diced
½ c. cooked green peas
salt
pepper
mayonnaise

1. *Mix ingredients just before serving. Serves 4.*

Kidney Bean Salad

4 strips crisp bacon, chopped
3 tbsp. onion, diced
½ c. celery, diced
1 c. diced red apples, unpeeled
1 c. cheese, diced
1 c. kidney beans, drained
½ tsp. salt
f.g. pepper
mayonnaise

1. *Combine ingredients just before serving. Serves 4-6.*

Salmon Salad

1 c. cold, cooked salmon, fresh or canned
1 c. cabbage, shredded or celery, diced
mayonnaise
or cooked salad dressing
½ tsp. salt
f.g. pepper

1. *Combine flaked salmon, shredded cabbage, or diced celery and dressing.*
2. *Season with salt and pepper to taste. Serves 4.*

Tomato Jelly Salad

2 tbsp. gelatine
½ c. cold water
3 c. canned tomatoes
¼ c. onion, diced
½ c. celery, diced
1 bay leaf
1 clove
¼ c. green pepper, diced (optional)
1 tsp. sugar
½ tsp. salt

1. *Soak gelatine in cold water.*
2. *Heat tomatoes with seasonings, covered. Strain.*
3. *Add to soaked gelatine, stirring until gelatine dissolves.*
4. *Pour into moulds moistened with water, oil or mayonnaise.*
   Chill until firmly set.
   Serves 6.

A quick and easy dessert. Try an assortment of cheese.

Desserts

The dessert recipes given here are mainly those using plenty of milk. You will remember that cooking milk scarcely changes the food value so go ahead and cook to your heart's content.

Fruits can also be used as supper desserts. This is a good place to practise that second Food Rule (page 3) "One serving of citrus fruit or tomatoes or their juices; and one serving of other fruit". Citrus fruit serves as a starter or dessert and our wide variety of available fruits can serve as the second fruit.

Fruits have more to offer than sweets. Sweets are packed with calories and little else in the way of food value. The extra calories help to add inches to your hips. It is a well-known fact that sweet foods help to promote tooth decay. Sweet foods, containing little or no minerals and vitamins, are expensive, when food value is considered. On the other hand, fresh fruits are low in calories and supply us with some minerals and vitamins.

If you are pressed for time, arrange an easy-to-serve cheese and fruit dessert. A variety of cheese can accompany a variety of fruit. Fresh grapes, pears or apples are delightful companions to your favourite cheeses.

Apple Whip

1 c. evaporated milk
2 tbsp. lemon juice
1 c. -2 c. sweetened apple sauce

1. *Chill milk thoroughly, then whip until stiff.*
2. *Fold in lemon juice and cold apple sauce. Serves 6. Prune or apricot pulp may be used.*

Tapioca Cream

1 egg yolk
3 c. milk
¼ c. quick-cooking tapioca
⅓ c. sugar
¼ tsp. salt
1 egg white
1 tsp. vanilla

1. *Mix beaten egg yolk with ½ c. milk in saucepan.*
2. *Add tapioca, sugar, salt and remaining milk, mixing well.*
3. *Heat quickly until it boils, stirring constantly, then remove from heat.*
4. *Beat egg white until stiff. Fold hot mixture slowly into egg white. Cool. Add vanilla. Serves 6.*

Quick Rice Pudding

½ c. minute rice
¼ tsp. salt
1 c. water
1½ c. milk
1 egg, beaten
½ c. sugar
½ tsp. nutmeg
1 tbsp. butter
½ c. raisins

1. *Combine rice, salt and water in pan. Cover and boil gently 4 minutes.*
2. *Combine milk, egg yolk and add to rice.*
3. *Add sugar, nutmeg, butter and raisins.*
4. *Bring to full rolling boil, stirring constantly.*
5. *Remove from heat, cover and let stand 10 minutes. Serve warm. Serves 6.*

Baked Custard with Caramel Sauce

2 c. scalded milk
⅓ c. brown sugar
3 eggs, slightly beaten
⅛ tsp. salt
½ tsp. vanilla

1. *Sprinkle brown sugar in bottom of casserole, 1½ qt. size.*
2. *Slowly stir scalded milk into eggs.*
3. *Add salt and vanilla. Strain. Pour over brown sugar. Do not stir.*
4. *Oven-poach custard in moderate oven, 350°, 1 hour, or until knife put into middle of custard comes out clean. Serves 4-5.*

Lemon Crumb Pudding

2 c. scalded milk
2 c. dry bread crumbs
¼ tsp. salt
¼ c. sugar
1 egg, well beaten
grated rind 1 lemon
3 tbsp. lemon juice
1 tbsp. melted fat

1. *Pour scalded milk over fine bread crumbs. Add remaining ingredients.*
2. *Mix and pour into greased casserole, 1½ qt. size.*
3. *Bake in slow oven, 325°, 45 minutes. Serve hot with Lemon Sauce, (below) or cream or top milk. Serves 4-6.*

Lemon Sauce

1 tbsp. cornstarch
or
2 tbsp. flour
⅓ c. sugar
grated rind 1 lemon
1 c. cold water
1½ tbsp. butter (optional)
juice of 1 lemon, strained

1. *Mix cornstarch, sugar and lemon rind.*
2. *Slowly add water. Stir.*
3. *Cook, stirring until sauce is thick and clear.*
4. *Serve hot, adding butter and lemon juice just before serving.*

Fruit Crisp

6 apples, sliced
½ c. brown sugar
½ c. whole wheat flour
½ tsp. nutmeg
⅛ tsp. salt
¼ c. brown sugar
⅓ c. quick-cooking rolled oats
¼ c. butter

1. *Sprinkle brown sugar over apples in greased casserole, 1½ qt. size.*
2. *Mix and sift flour, nutmeg, salt and brown sugar. Stir in rolled oats. Cut in butter as in pastry making.*
3. *Spread flour mixture over apples.*
4. *Bake in moderate oven, 350°, about 50 minutes, or until crust is lightly browned. Serve plain or with cream. Serves 5.*

NOTE:
This recipe may be used for other fruit such as rhubarb, peaches, or tart plums.

Cream Cheese Whip

1 pkg. (4 oz.) cream cheese
½ c. cream

1. *Mash cream cheese with a fork.*
2. *Stir in cream until smooth. Makes ¾ c. to serve with fresh or frozen berries.*

Cheesed Biscuits

Cheese Mixture

3 tbsp. butter
3 tbsp. pimiento cheese
For Tea Biscuit Recipe, see page 13.

1. *Measure butter and cheese into 8" pie plate. Place in preheated oven until partially melted.*
2. *Sift dry ingredients into mixing bowl.*
3. *Cut in fat.*
4. *Add milk, all at one time. Stir until mixture leaves sides of bowl.*
5. *Knead gently on lightly floured board, 1 minute. Pat to 1" thickness. Cut.*
6. *Blend cheese mixture well with fork. Arrange biscuits close together in mixture.*
7. *Bake in very hot oven, 450°, 15-20 minutes or until nicely browned.*

Frozen Fruit Tarts

1 pkg. (4 oz.) cream cheese
2 tbsp. cream
6 baked whole wheat tart shells
frozen or fresh peaches, strawberries, blueberries or raspberries
currant jelly

1. *Blend cream cheese with cream. Spread on bottom of tart shells.*
2. *Fill with desired fruit.*
3. *Melt jelly over boiling water and spoon over fruit. Chill. Serves 6.*

ACKNOWLEDGEMENTS

The co-operation of the following organizations in the preparation of this bulletin has been appreciated:

BORDEN COMPANY LIMITED • KRAFT FOODS COMPANY

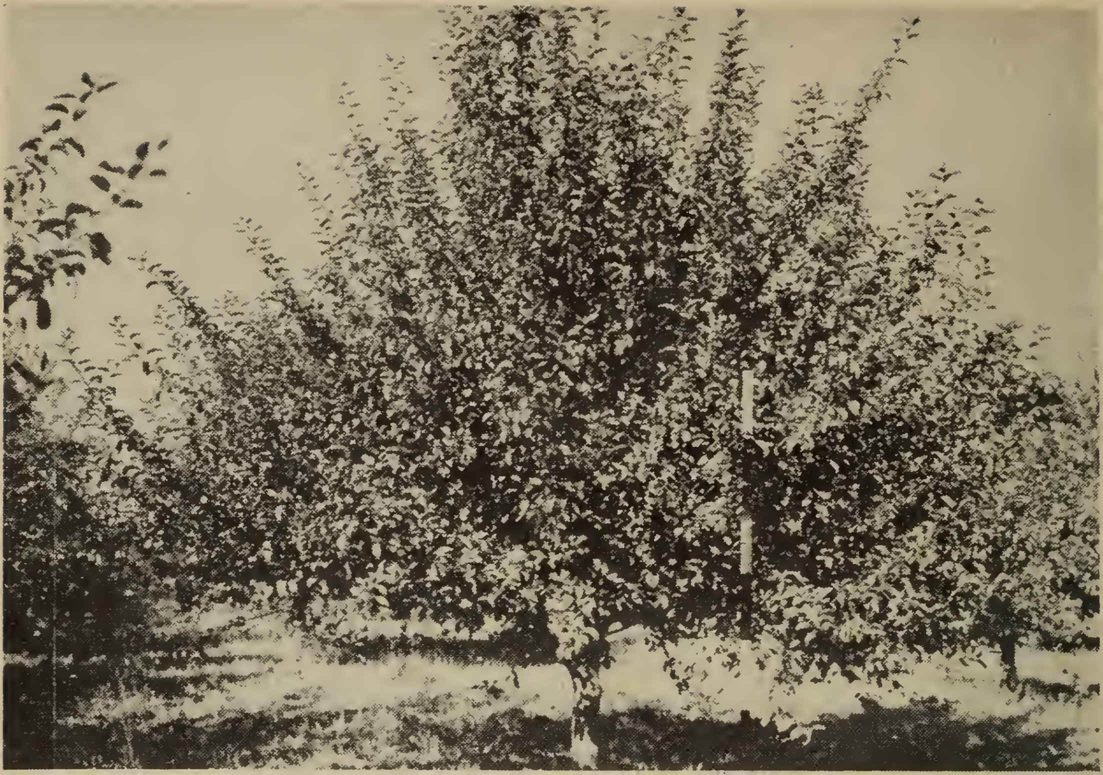
TREE FRUITS and GRAPES
FOR THE
HOME GARDEN

●

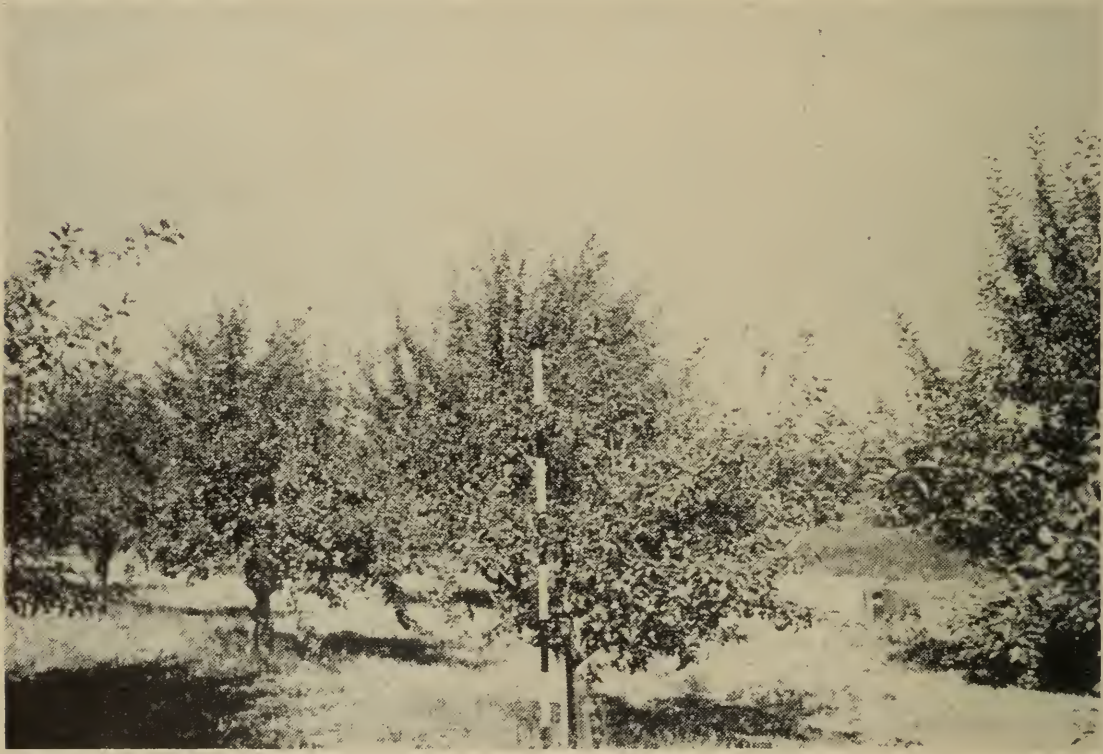
By W. H. UPSHALL
HORTICULTURAL EXPERIMENT STATION
Vineland Station, Ontario

ONTARIO DEPARTMENT OF AGRICULTURE
Statistics and Publications Branch, Toronto, Ontario

Bulletin 480 May, 1951



A McIntosh apple tree on a standard rootstock ten years after planting. The home gardener is faced by a difficult spray problem with such high trees.



A McIntosh apple tree of the same age on a dwarfing rootstock, Malling IX. The two pictures were taken at the same distance from each tree.

TREE FRUITS AND GRAPES FOR THE HOME GARDEN

THE GROWING of a portion of the family's requirement of the tree fruits and grapes in the home garden can be an interesting feature of home life. The home owner should not, however, be misled by handsome color pictures in nursery catalogues into thinking that nature takes care of these plants and that the owner merely has to harvest the luscious fruit. Actually, it will prove to be a continuous fight against insect pests and plant diseases — nevertheless a challenging encounter. Unless there is sure to be a continuing determination to control these enemies do not plant fruit trees, even remove those already present. There are innumerable kinds of trees more suitable for shade purposes. In any case, do not plant more fruit trees than are required for the family fruit supply else the care of them may become too burdensome.

For home-garden use, dwarf apple and pear trees are more suitable than the larger standard trees but dwarf nursery trees are more expensive. The best dwarfing rootstocks are Malling IX for apple and Angers quince for pear. All of these trees require continuous support throughout their whole life or they may blow over or break at the union. They should be planted shallow, with the graft union continuously above the ground level.

There are no generally satisfactory dwarfing rootstocks for the stone fruits, i.e. cherries, plums, peaches, apricots. Having in mind ease of pest control and other operations, it is advisable to select varieties of these fruits that do not produce large trees.

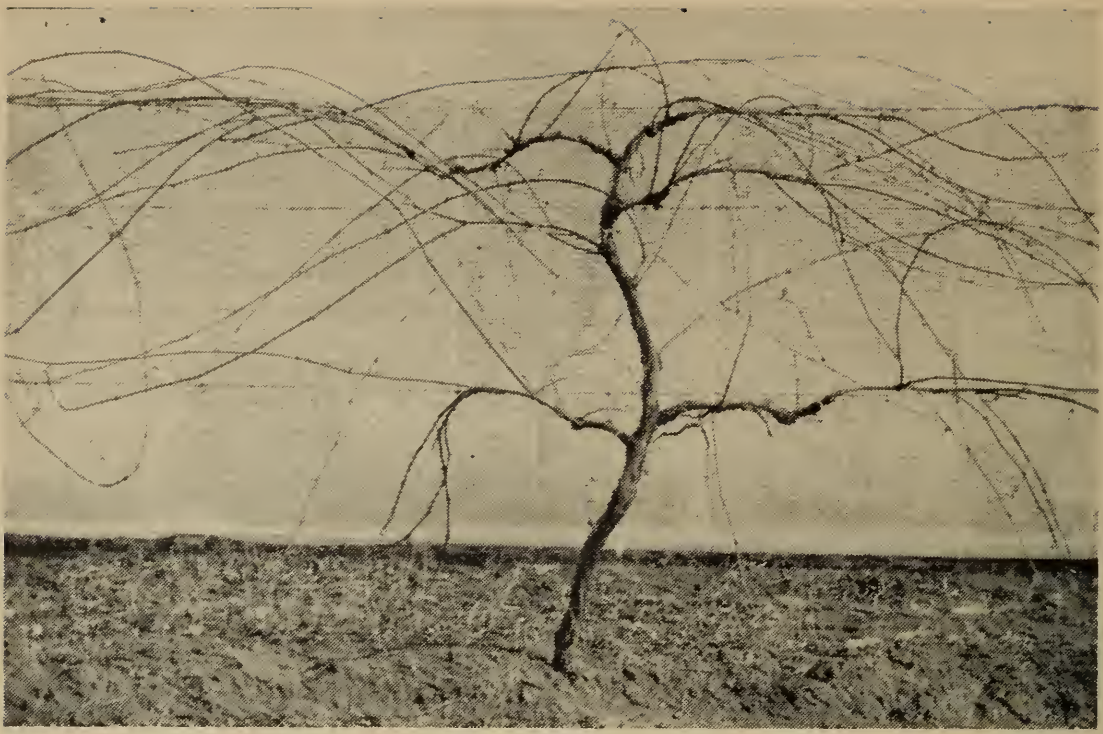
"Five in one" fruit trees are now available from a few nurseries. In such cases five varieties of fruit have been grafted on the one trunk. Thus, from one tree the owner can have fresh fruit over a longer period because the maturity time of the varieties can range from early to late season. These trees are of special value where there is space for only one tree of a kind.

Soil

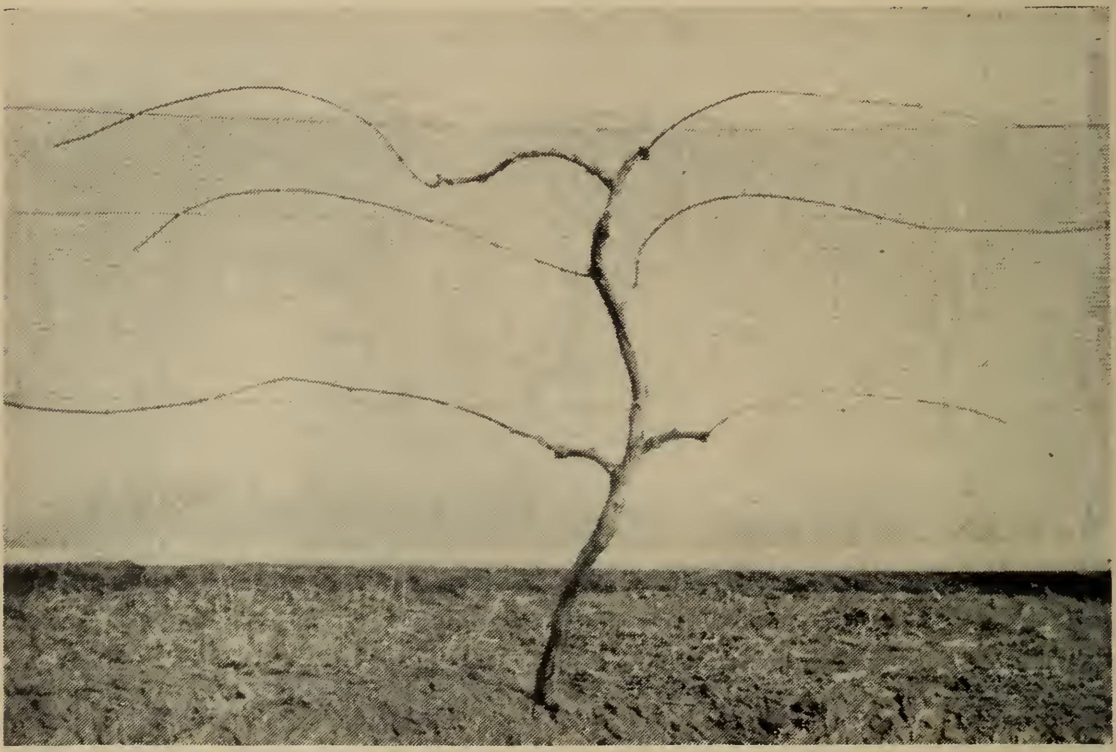
Usually there will be little, if any, choice of site or soil in the home garden. None of the tree fruits or grapes does well on a poorly drained soil. They may survive under such conditions but the yield will be disappointing. Provided drainage is satisfactory, the plants will do well on a wide range of soil types but cherries and peaches are not partial to clay soils.

Nursery Stock

The choice of nursery stock is important. Cheap trees are often a poor investment. They may be undersized, weak, or partially dried out. Make sure of the guarantee concerning the tree with respect to trueness-to-name, and to replacement if the tree does not survive the transplanting operation. For standard trees



A grape vine being grown on the three-wire system showing the arms tangled each way along the wires before the vine has been pruned in early March.



The same vine after pruning. Select new arms that originate as near the main trunk as possible and leave a total of 40 to 60 buds on each mature vine.

accept only those on proven rootstocks — French Crab or American Domestic seedlings for apple, French pear or Bartlett seedlings for pear, Myrobalan for plum, Mazzard or Mahaleb for cherry (the Mahaleb only on deep sandy soils), and peach seedlings for peach. Except for peach, where one-year trees are the rule, two-year or older trees are preferred. Where fruit trees are to be planted outside of the commercial fruit areas, consult the nearest Experiment Station for suitable varieties and rootstocks.

Pollination

In apples, pears, plums and sweet cherries, two or more varieties of a given kind of fruit should be planted side by side or at least within 100 feet of one another in order to permit cross-pollination by bees and other insects. A tree of McIntosh apple, for instance, would bear little if any fruit if isolated from other apple varieties. Pear pollen is not effective on an apple variety, plum pollen is useless on cherry, and so on. The pollinating variety must be of the same kind of fruit. It is best to use two Japanese plum varieties for cross-pollination, and two European varieties, since these two species are not very effective pollinators for one another.

Varieties

The home gardener may choose to grow high quality varieties which, in commercial orchards, have weaknesses, such as low yield. This fact has been kept in mind in making the following recommendations, which, in each fruit, are in order of maturity.

APPLES: Lodi, Melba, Joyce, Milton, McIntosh, Cox Orange, Delicious, Wagener, Jonathan, Secor, Golden Delicious, Spy.

PEARS: Giffard, Clapp Favorite, Bartlett, Flemish Beauty, Conference, Seckel, Anjou, Bosc, Sheldon.

PLUMS: *Japanese*—Early Golden, Wrights' Early, Shiro, Burbank. *European*—Czar, Lombard, Imperial Gage, Stanley, Italian Prune.

SWEET CHERRIES: *Black*—Early Lyons, Black Tartarian, Bing, Windsor, Hedelfingen. *White*—Victor, Napoleon.

SOUR CHERRIES: Montmorency.

APRICOTS: Naramata, Geneva.

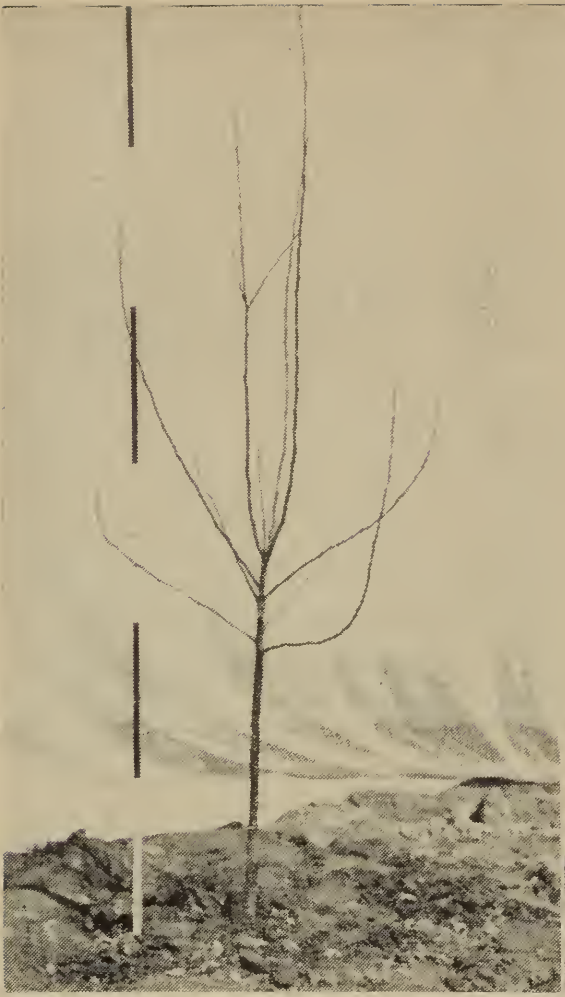
PEACHES: Redhaven, Golden Jubilee, Vedette, Veteran.

GRAPES: *Blue*—Buffalo, Fredonia, Concord (southern areas only). *White* — Seneca, Ontario. *Red* — Brighton (self-unfruitful), plant adjacent to one of the above varieties.

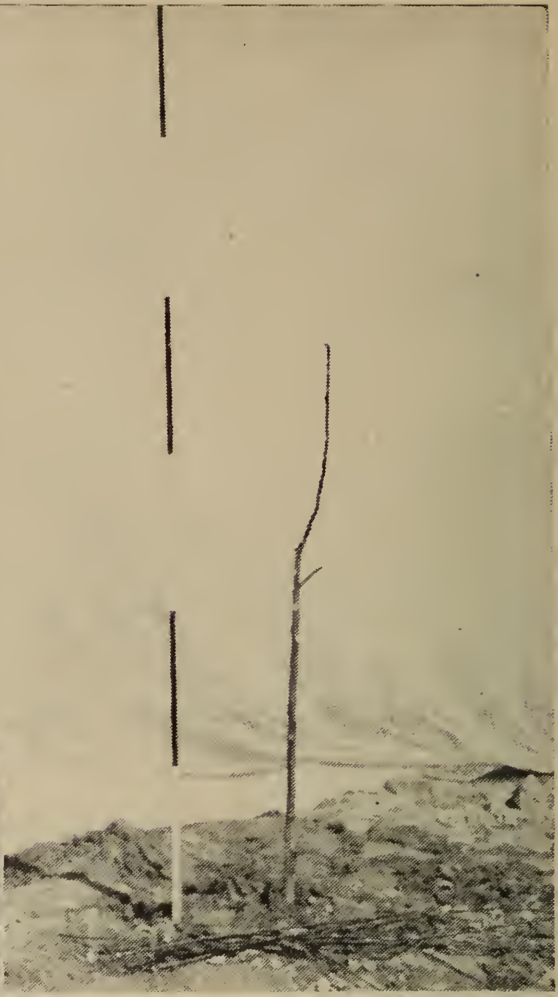
Planting

With the exception of peaches, all fruit trees, if two-year or older, can be safely planted in the fall. Mid-November is a good time. However, spring planting will give equally good results if done early, i.e., very soon after the soil is fit for planting. Plant as far as possible from buildings so there will be a minimum drift of spray or dust towards them. Both sprays and dusts are destructive to paint and the women folk will not appreciate having the windows of the house smeared with spray residue.

Dig a hole large enough to accommodate the root system of the tree and of a depth to allow the graft union to be well above ground, especially important for dwarf trees. Tramp the soil well around the roots



A typical two-year-old fruit tree from a nursery — before pruning.



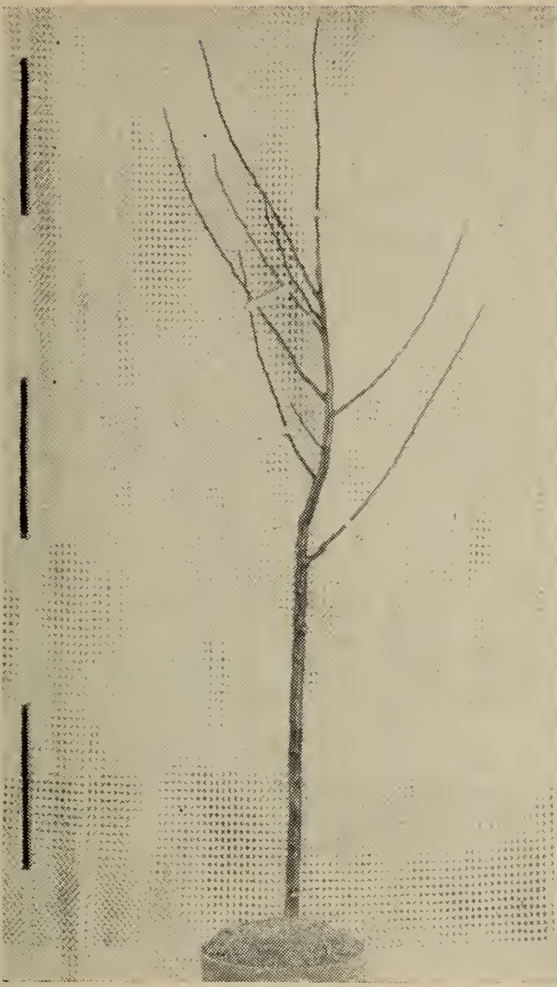
Same tree after pruning. Remove much of the head to produce a strong tree.

and water thoroughly. Repeat the watering at weekly intervals if dry weather prevails. Because of the hazard from mice it is advisable to place a quarter-inch mesh galvanized wire cylinder several inches deep around the tree, immediately after planting.

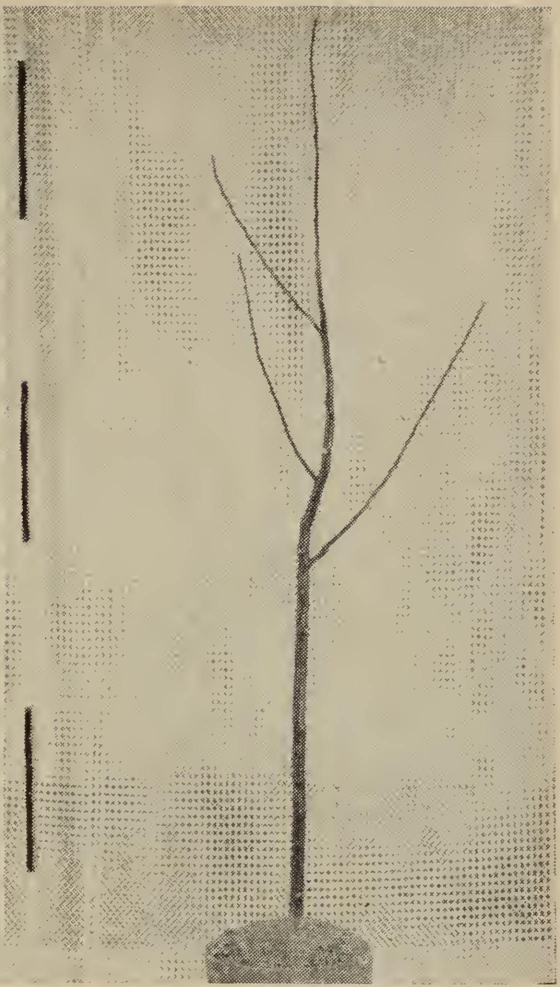
Training and Pruning

After the tree is planted it should be pruned as shown in the illustration. The following year three or four branches having wide angles with the trunk may be selected as a permanent framework. The others should be pruned off close to the trunk. After this pruning, very little need be done until the tree comes into bearing. Then regular annual pruning comes into the program, made up for the most part with the removal of weak wood which, if left intact, would bear inferior fruit. All pruning should be done in early spring—not in the fall or winter.

Unlike the fruit trees, grape vines should be pruned heavily each year. They are most easily handled on three wires, as illustrated. There should be a single straight trunk from which six arms arise, preferably below the wire in each case. These arms are tied to the wires—but not so tightly that girdling re-



The same tree one year after planting: the selected branches are marked.



Little pruning is required after this selection until the tree bears fruit.

sults at the tie. Each year, new arms should be retained, all excess wood being removed. For a vine three years and up, a total of 40 to 60 buds (seven to ten per arm) should be left. The more vigorous the growth the more buds the owner should leave.

Soil Management

It will not be necessary to feed the soil around fruit trees as heavily as the vegetable garden but it should not be neglected. The mulch system of culture is a good one, for the breakdown of the mulch will furnish enough nutrients for the tree without other additions. A mulch may be of weeds, vegetable refuse, lawn clippings, sawdust, leaves, old straw or hay. It should extend beyond the spread of the branches and be sufficiently deep to keep plants from growing up through it. If your fruit trees are on a lawn or in sod, nitrogen applications in early spring are a necessity — a minimum of one-quarter pound of ammonium nitrate for each year of the tree's growth. Cultivation, if given at all, should not be continued beyond the end of June.

Spraying

A spray calendar for all tree fruits in the home garden is available from the Entomology Department at the Ontario Agricultural College, Guelph. The sprays given therein are the minimum number required and should be supplemented in periods of wet weather. If a spray outfit is not readily available, a thorough dusting with a mixture of dusting sulphur (nine parts) and arsenate of lead (one part) will be effective for most insects and diseases, providing it is done when there is little wind and when leaves and fruit are wet with dew or rain. To be equally effective, more dustings will be required than is recommended for the sprays. If perfection in the fruit is the goal, follow the spray calendar for commercial orchards.

For peach leaf curl and for most scale insects spray with liquid lime sulphur, one part to seven parts of water, in the early spring before the buds burst. If the psylla insect is troublesome on pear trees, consult your nearest Experiment Station about control measures.

Fruit Thinning

In the month of June it is usual for a portion of the young fruits to drop off. This is a natural fruit thinning. With some varieties, however, too many fruits may remain after this drop—too many for the tree to mature to the best quality. Most apple, pear, and peach varieties should not have fruits closer than eight inches from centre to centre and plums should be spaced sufficiently far apart that they do not touch one another when mature. If there is an overabundance of fruits on the tree, hand thinning in early July will result in better fruit and protect the tree from the excessive drain on its reserves.

A quarter-inch mesh galvanized wire cylinder should be used around the base of each tree as a protection against trunk-girdling by rodents.

Harvesting

The home owner can leave his fruit on the tree until it commences to drop or until it reaches peak quality. The commercial orchardist cannot take chances on loss from a windstorm and is, therefore, forced to pick a few days earlier. It is difficult to explain to an inexperienced grower how to determine the proper harvesting time. For the best quality, pears must be picked well in advance of the ripe stage and ripened at room temperature. Summer apples, plums and peaches may be left on the tree until nearly at the eating-ripe stage. Winter apples, like pears, must be picked while still hard. Cherries and grapes may be left on the plant until reaching the prime eating condition.

COMMON GRAIN SMUTS and THEIR CONTROL

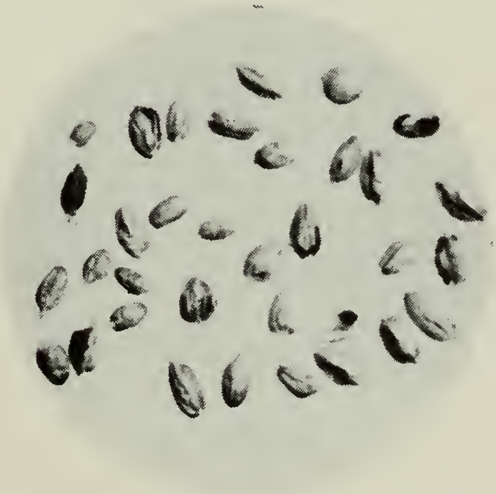
by
D. R. SANDS
Department of Botany
ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

SEED TREATMENT

Gives this ▶

HEALTHY WHEAT

Prevents this ▶



BUNT OF WHEAT

ONTARIO DEPARTMENT OF AGRICULTURE
Statistics and Publications Branch, Toronto, Ontario
Bulletin 481 July, 1951

The author wishes to acknowledge the helpful suggestions of Dr. J. D. MacLachlan in the preparation of this bulletin and also the Department of Public Relations for the photographs.

INDEX

Page

BUNT (STINKING SMUT) OF WHEAT 4

LOOSE SMUT OF WHEAT 5

LIFE CYCLE OF BUNT 6

LIFE CYCLE OF LOOSE SMUT 7

COVERED SMUT OF BARLEY 8

COMMON OR BROWN LOOSE SMUT OF BARLEY 9

OAT SMUTS 10

CORN SMUTS 11

SEED TREATMENT 13

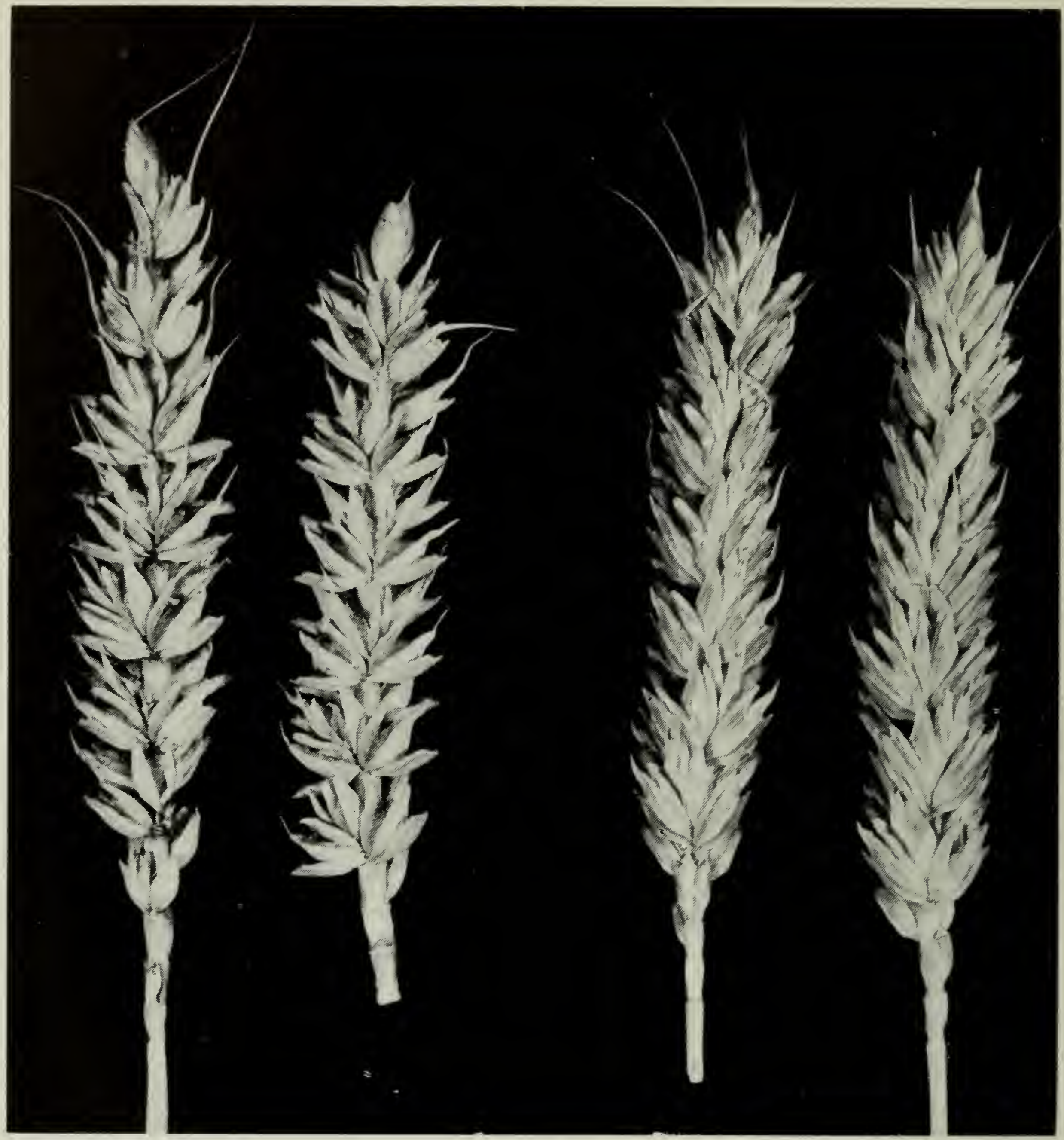
SEED TREATERS .... 12, 14 and 16

INTRODUCTION

The primary purpose of this bulletin is to provide information to help farmers and other interested persons in the identification of the grain smuts common in Ontario and to acquaint them with the methods by which these diseases may be controlled.

The losses in many grain crops, due to smut, is often much greater than the farmer realizes unless he is a close observer of his crop. Some smuts that are quite noticeable soon after the grain comes into head will disappear before harvest time leaving only a bare stalk and hence pass unnoticed.

Each smut is caused by a small plant called a fungus. A fungus has no green colour and hence cannot manufacture its own food as green plants do. These fungi that cause the smuts are very small and live as parasites on the grain plants. In so doing, they weaken the plants and either completely destroy the grain of the diseased plant or affect it in such a manner that the seed should be treated to kill the smut fungus before sowing.



BUNT (STINKING SMUT) OF WHEAT HEALTHY HEADS

Bunt (Stinking Smut) of Wheat

When Seen — After the wheat has headed out and until harvest time.

Appearance — The diseased heads remain green longer than the healthy heads. They stand more erect and do not colour as much as the healthy heads do when the grain is ripening.

In place of good kernels of wheat, dark, shrunken structures develop, hence the name "Bunt". These structures are often called "smut balls". See cover page. A "smut ball" contains a few million spores; these are the "seeds" of the fungus. The "smut balls" are broken open during harvesting and threshing and the spores are scattered. The spores produce a fishy odour, hence the name "Stinking Smut".

Control — Chemical seed treatment will control this disease. See seed treatment page 13. The fungus causing this disease is carried to the following crop as smut spores **on the kernels** of wheat. See chart on page 6.

Loose Smut of Wheat

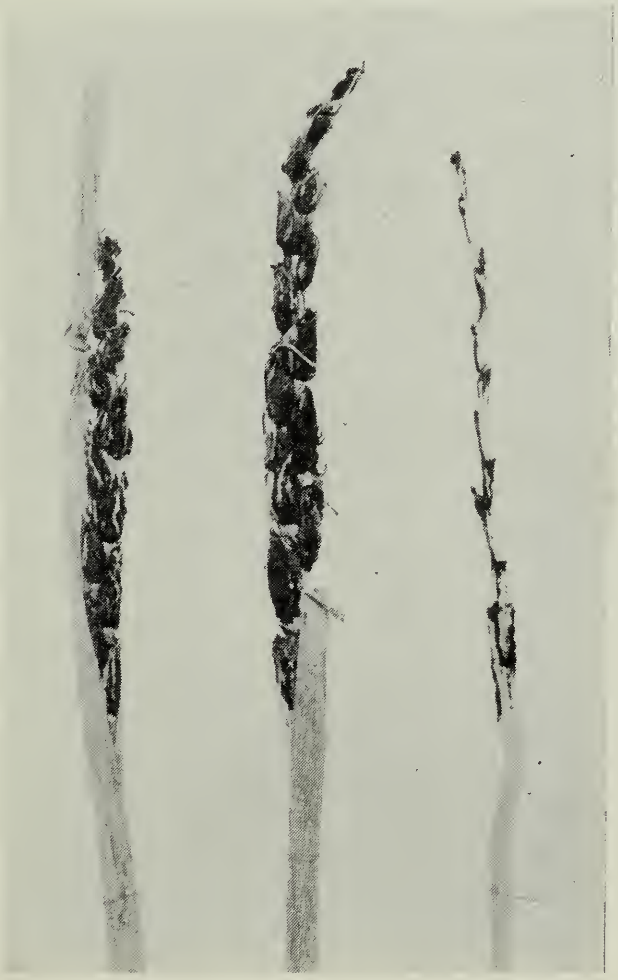
When Seen — As the wheat is coming into head. Diseased heads push out of the boot slightly earlier than the healthy heads.

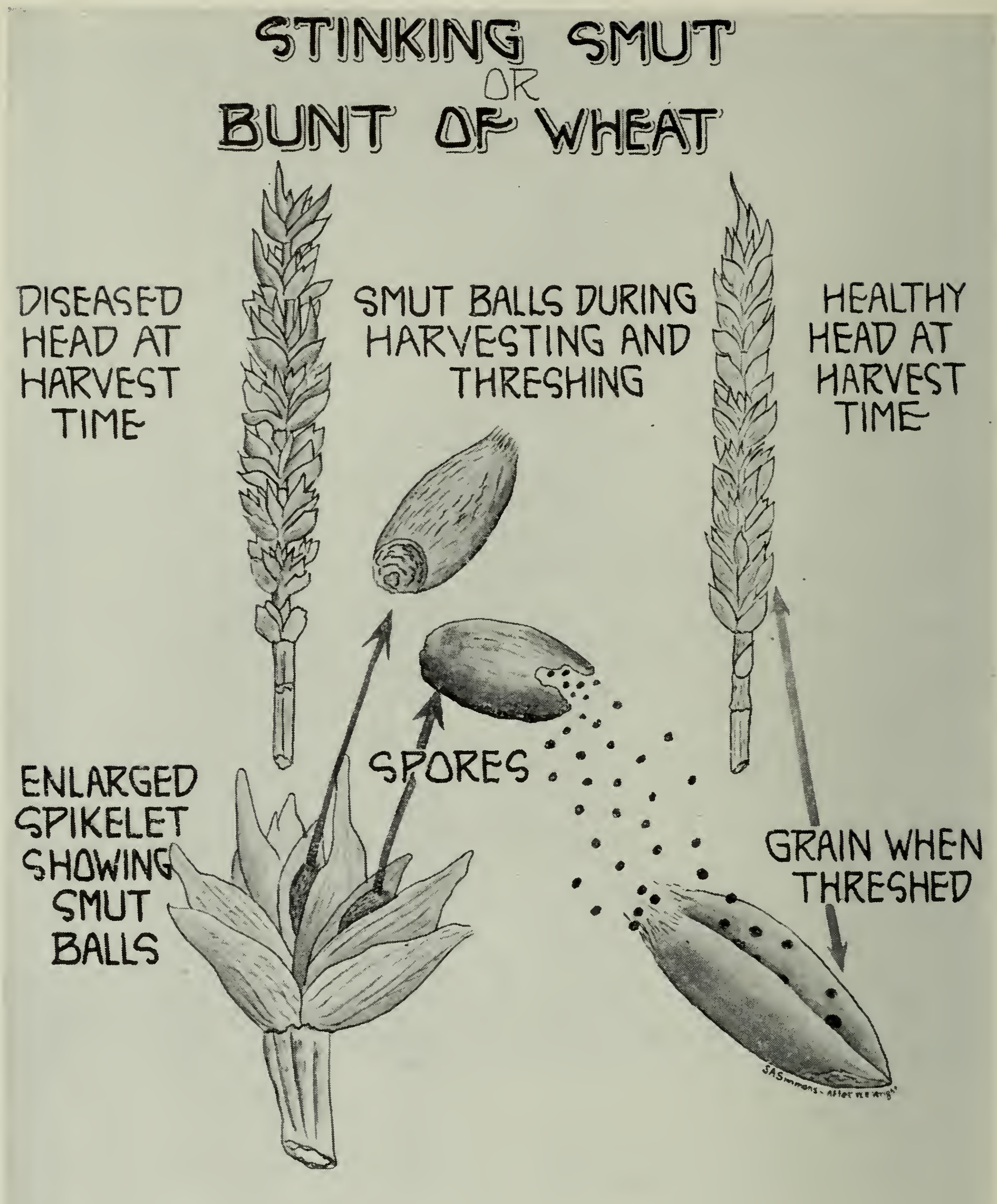
Appearance — A conspicuous black mass appears in place of a healthy head. This black mass is composed of tiny spores that are scattered during the time the healthy heads are in blossom. Some of them infect the part of the blossom from which the kernel of wheat develops. At harvest time only the bare stalk remains.

Control — Chemical seed treatment is of no value. See hot water treatment page 18. The fungus causing this disease is **within** the germ of the wheat kernel and in this way the disease is carried to the following crop. See chart on page 7.

Of the three common wheat varieties in Ontario, Cornell 595 is the most resistant to Loose Smut. Dawbul is fairly resistant, and Dawsons Golden Chaff is susceptible. All three of these are susceptible to Bunt.

LOOSE SMUT OF WHEAT




STINKING SMUT
OR
BUNT OF WHEAT
DISEASED HEAD AT HARVEST TIME
SMUT BALLS DURING HARVESTING AND THRESHING
HEALTHY HEAD AT HARVEST TIME
ENLARGED SPIKELET SHOWING SMUT BALLS
SPORES
GRAIN WHEN THRESHED
SASimmons - After

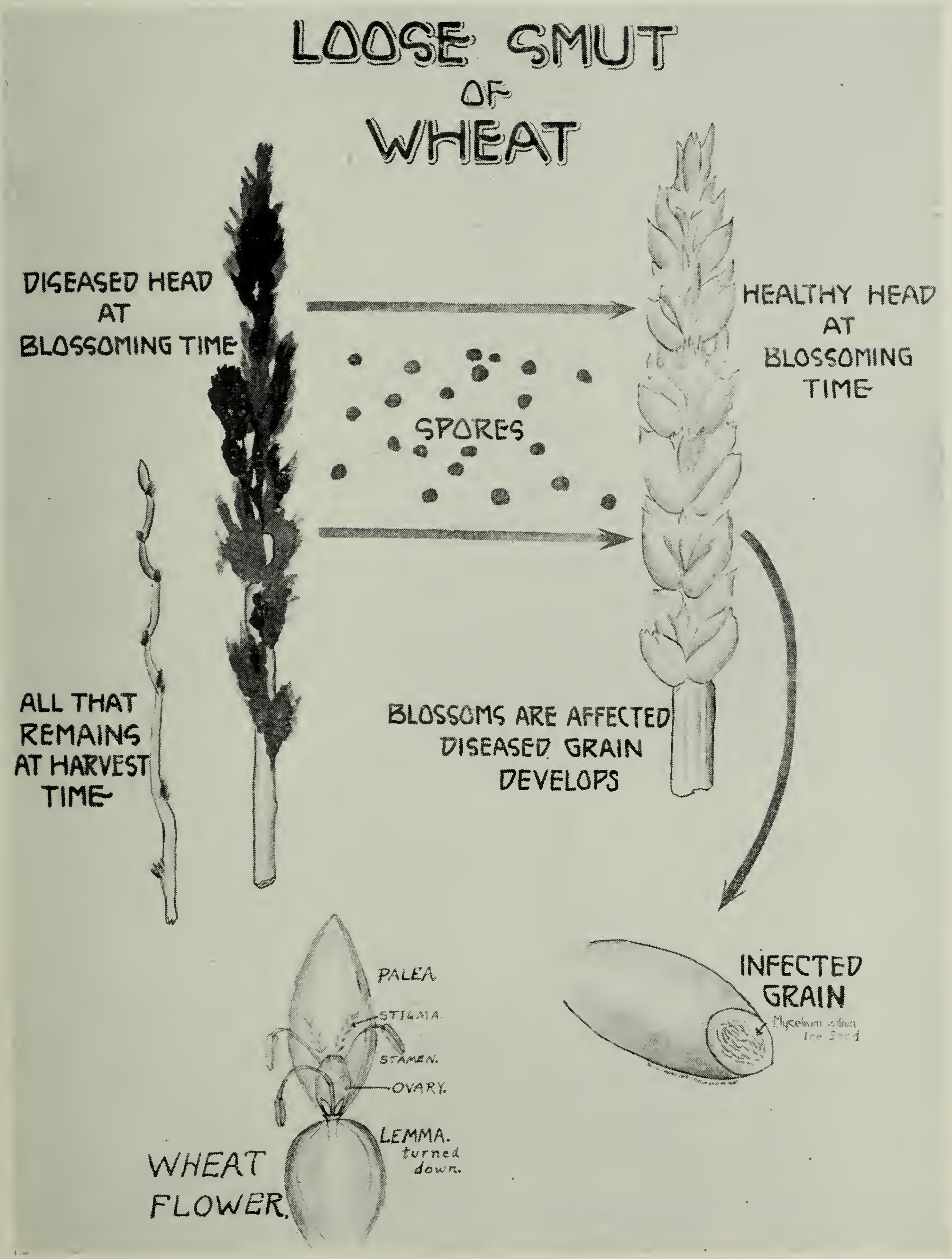
LIFE CYCLE OF BUNT

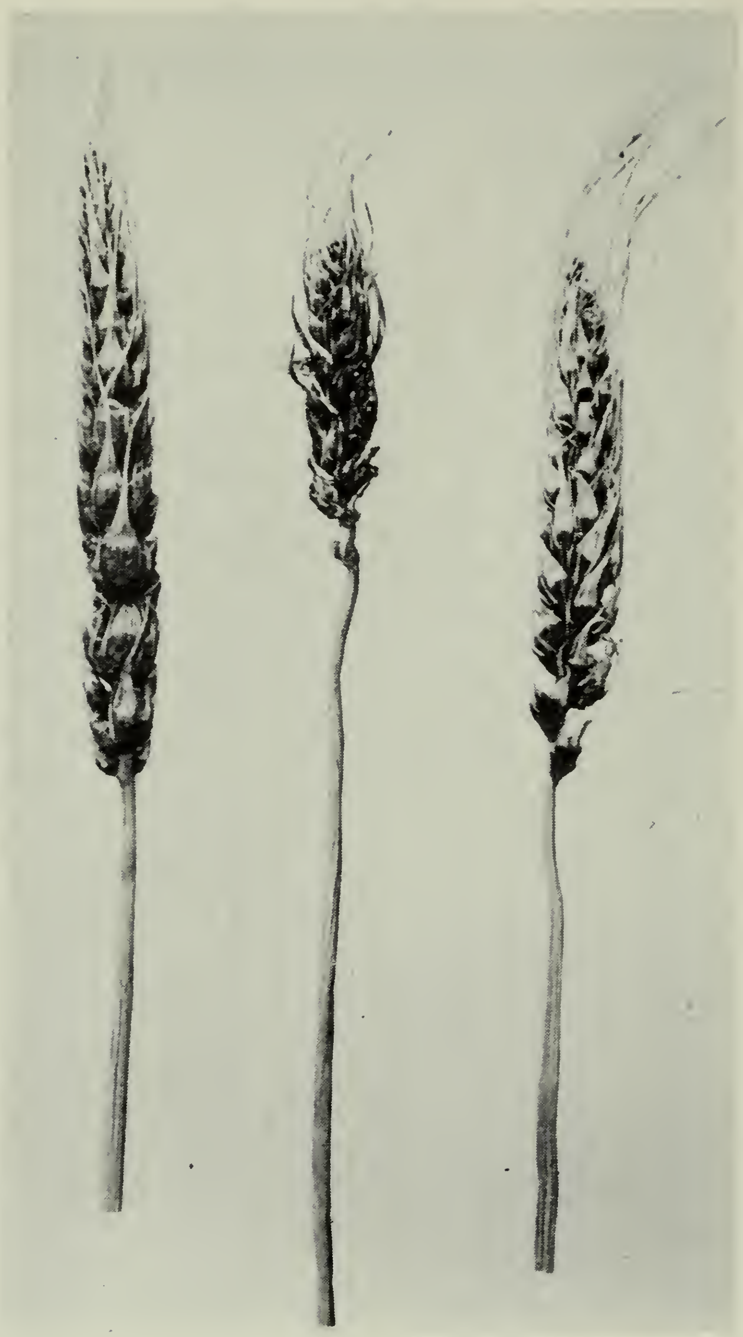
The above chart and the one on the next page illustrate the life cycle of two different types of fungi that cause smut in grain.

In the Bunt of wheat the fungus is on the **outside** of the seed in the form of spores. These spores can be killed with chemical seed treatment. See page 13.

In the Loose Smut of wheat the fungus is **within** the seed in the form of mycelium. It cannot be killed except by the hot water treatment. See hot water treatment page 18.

LIFE CYCLE OF LOOSE SMUT


LOOSE SMUT OF WHEAT
DISEASED HEAD AT BLOSSOMING TIME
SPORES
HEALTHY HEAD AT BLOSSOMING TIME
ALL THAT REMAINS AT HARVEST TIME
BLOSSOMS ARE AFFECTED DISEASED GRAIN DEVELOPS
INFECTED GRAIN
Mycelium within the Seed
PALEA.
STIGMA.
STAMEN.
OVARY.
LEMMA. turned down.
WHEAT FLOWER.



COVERED SMUT
OF BARLEY

Covered Smut of Barley

When Seen — After the barley has headed out. The diseased heads emerge about the same time as the healthy heads. They become more conspicuous as the crop reaches maturity. This disease is not common in Southern Ontario.

Appearance — A black mass of smut spores has replaced the barley grain. This black mass is enclosed within a persistent grey membrane. The spores are not scattered by the wind and rain unless the membrane is broken. During threshing the spore masses are broken up into lumps and these dark structures may be seen in the threshed grain.

Control — Chemical seed treatment will control this disease. See seed treatment page 13. The fungus causing the disease is carried to the following crop as smut spores on the surface of the grain or under the hull.

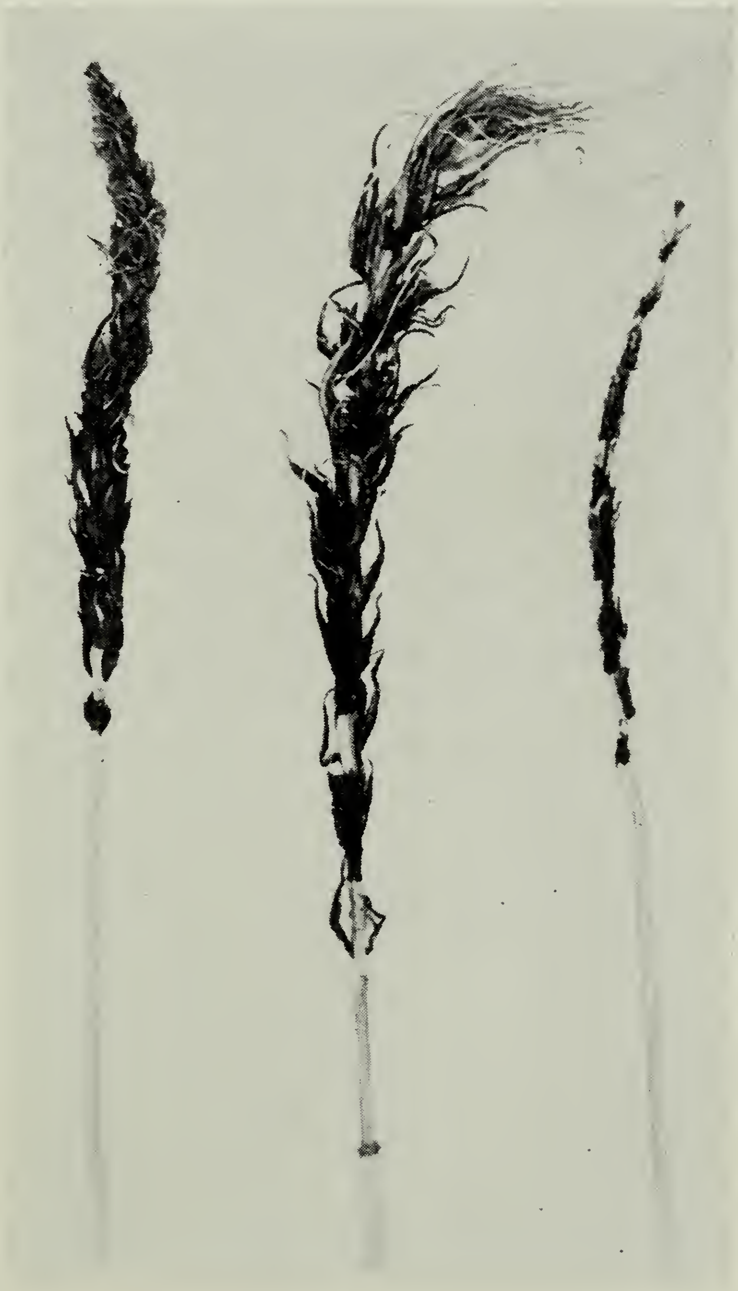
Brown Loose Smut of Barley

When Seen — As the barley is coming into head. The diseased heads emerge from the boot a little earlier than the healthy heads.

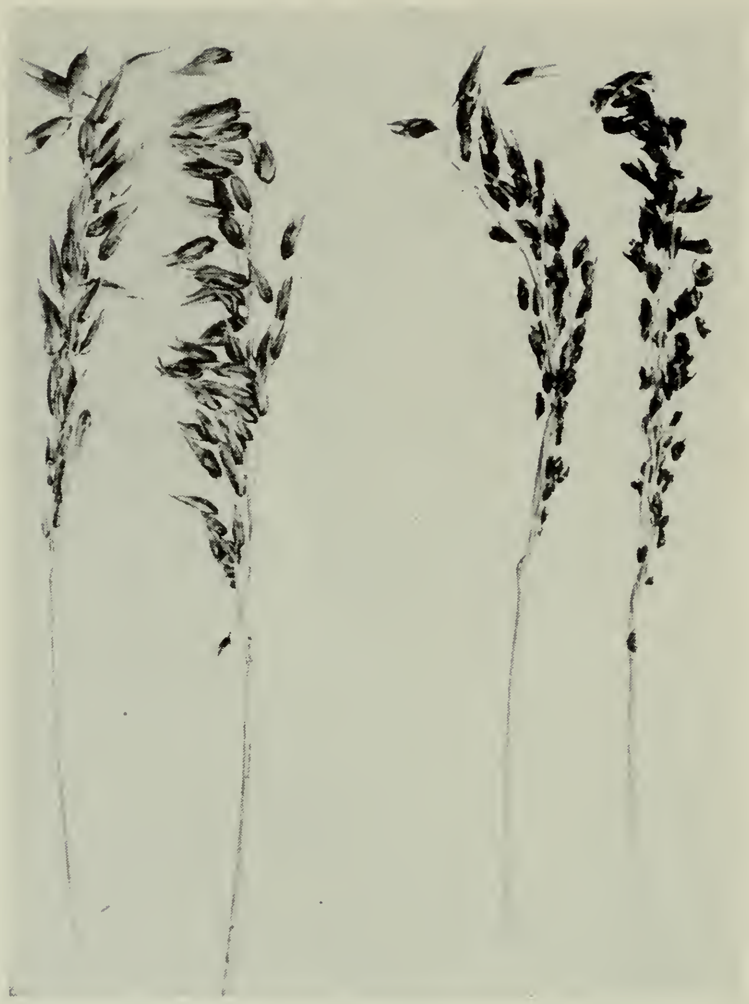
Appearance — A conspicuous sooty brown mass of spores appears in place of a healthy head of barley. At first this mass of spores is enclosed in a silvery membrane. This membrane usually breaks by the time the healthy heads are in blossom. The spores are scattered and some of them infect the part of the blossom from which the barley grain develops. At harvest time only the bare stalk remains.

Control — Chemical seed treatment is of no value. See hot water treatment page 18.

The fungus causing this disease is **within** the barley grain and in this way is carried to the following crop. It is much similar to Loose Smut of wheat. See chart page 7.



BROWN LOOSE SMUT
OF BARLEY



COVERED SMUT (on left)
LOOSE SMUT (on right)

Oat Smuts

When Seen — There are two smuts of oats: covered smut and loose smut. They look much alike in the field. Both of them may be seen when the oats head out and some smut remains until harvest. In some varieties of oats, covered smut may not be conspicuous until the crop is mature.

Appearance — When the oats head out, masses of black spores have replaced the oat grains and sometimes the chaff also. These spores are contained within a thin membrane. In the loose smut the membrane soon breaks and the smut spores are scattered leaving a more or less naked panicle (head). In the covered smut the membrane is more persistent and may remain until the ripening of the grain or even the threshing. The persistence of the membrane and the extent of damage to the panicle varies with the varieties.

Control — Chemical seed treatment will control both covered and loose smut. Ceresan M or formaldehyde may be used. See seed treatment page 13. The smuts causing these diseases are carried to the following crop as smut spores on the surface of the grain or under the hull.

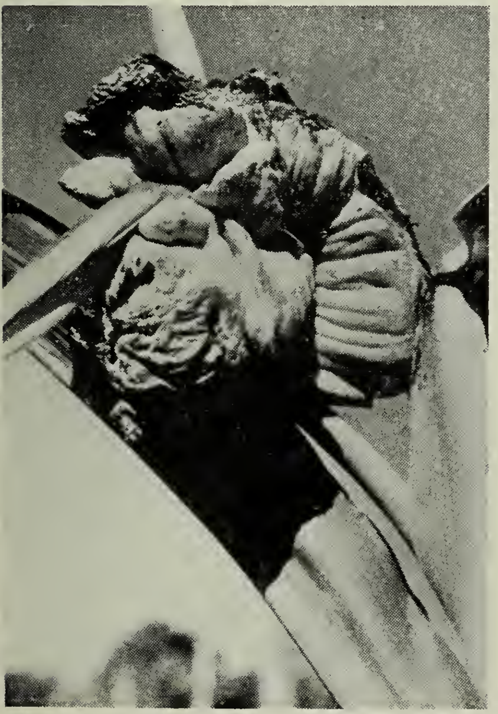
Corn Smut

When Seen — Any tender part of the corn plant may be affected during the growing season. Smut is usually seen from the mid growing period until harvest time. Late infections may occur where the plant has been injured.

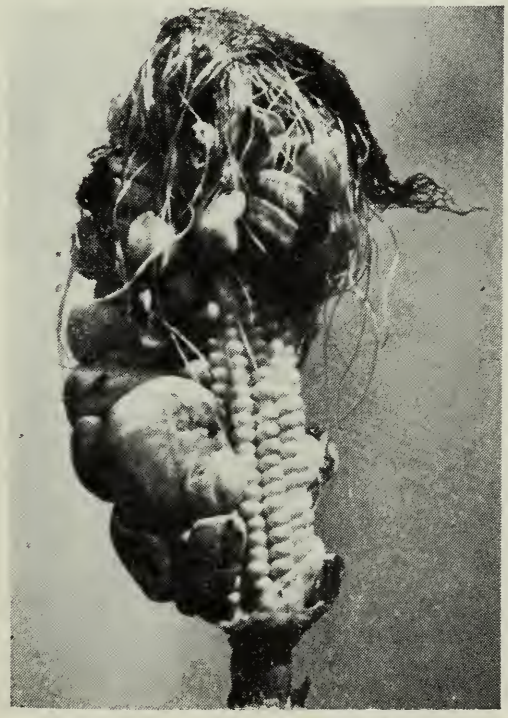
Appearance — It develops as conspicuous galls, often called "smut boils" on stems, leaves, cobs and tassels. In early stages the "smut boils" are light coloured and covered with a thin grey membrane. This membrane soon develops a polished or silvery luster. Later the interior of the "smut boil" becomes black. Finally the membrane breaks and a powdery black mass of spores is scattered by the wind and rain.

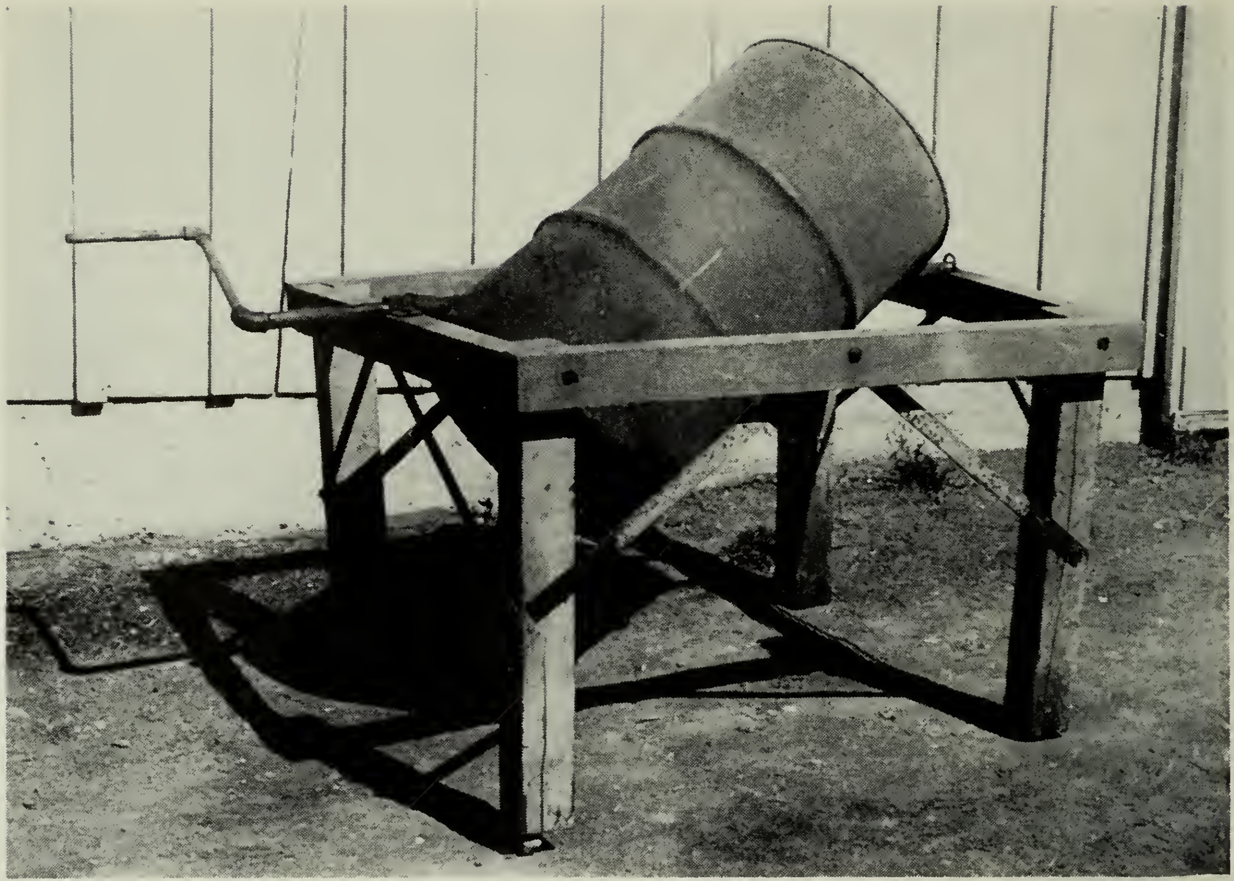
Control — There is no satisfactory method of control. It cannot be controlled by seed treatment because the spores of the fungus live over the winter in the soil or on crop refuse. A four year crop rotation seems to be of some value. In an isolated garden it is advisable to remove and burn the "smut boils" as soon as they develop. Seed corn is often treated before planting with chemicals such as Arasan S. F., but this is to control or check other diseases.

SMUT ON STEM



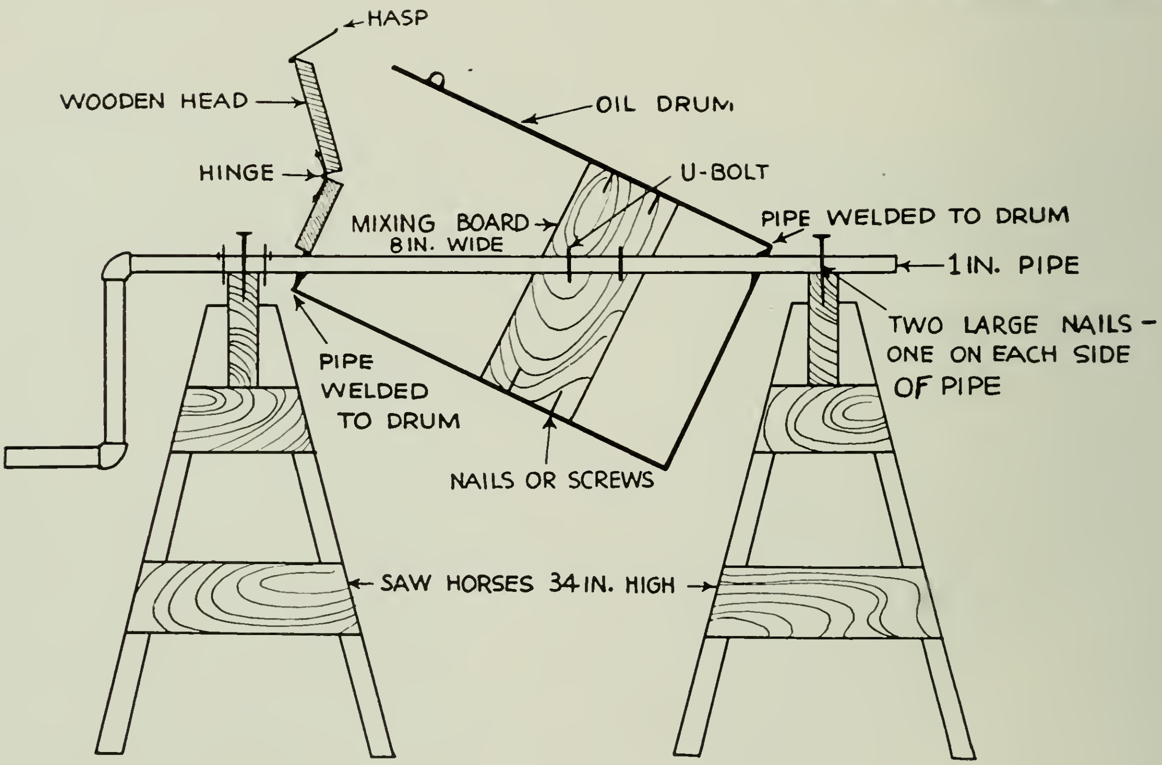
SMUT ON COB





DRUM IN A FRAME

DRUM SHOWING CONSTRUCTION



THIS TYPE OF TREATER ORIGINATED AT THE PENNSYLVANIA STATE COLLEGE

Seed Treatment

Bunt (stinking smut) of wheat, see page 4; covered smut of barley, see page 8; and the oat smuts, see page 10; can be controlled by seed treatment with chemicals. Why? Because the smut is carried on or near the surface of the seed. See chart page 6.

Loose smut of wheat, see page 5; and the common or brown loose smut of barley, see page 9; cannot be controlled by seed treatment with chemicals. Why not? Because the smut is carried within the seed. See chart page 7, and hot water treatment page 18.

Mercury compounds and formaldehyde are the chemicals that are in general use at present.

In addition to controlling smut, treated seed often gives a better stand as the seed is protected from other troublesome soil fungi during germination.

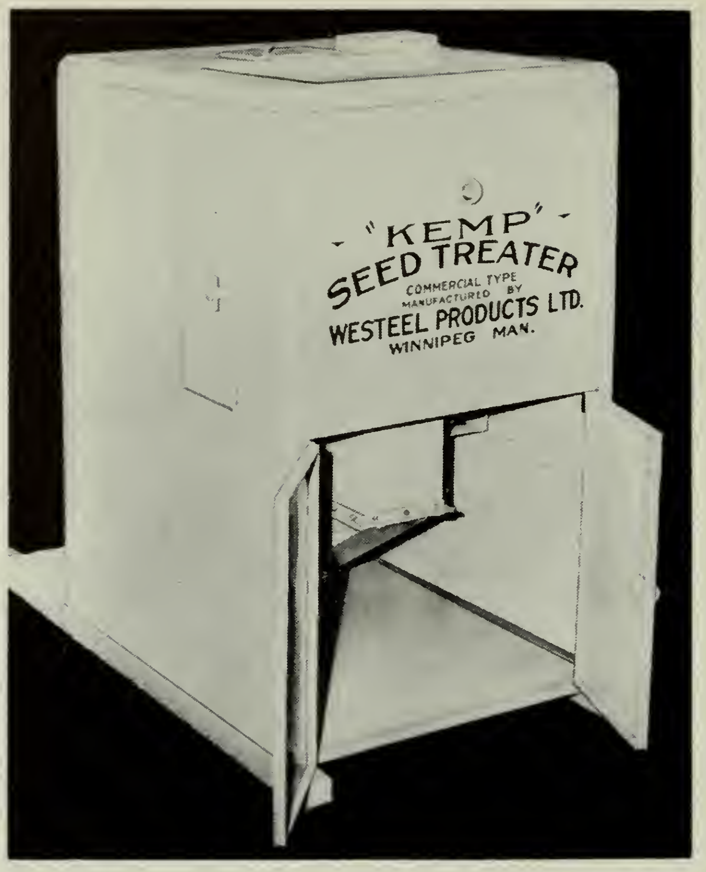
(A)—CHEMICAL SEED TREATMENT

(Mercury compounds and formaldehyde)

I Mercury Compounds

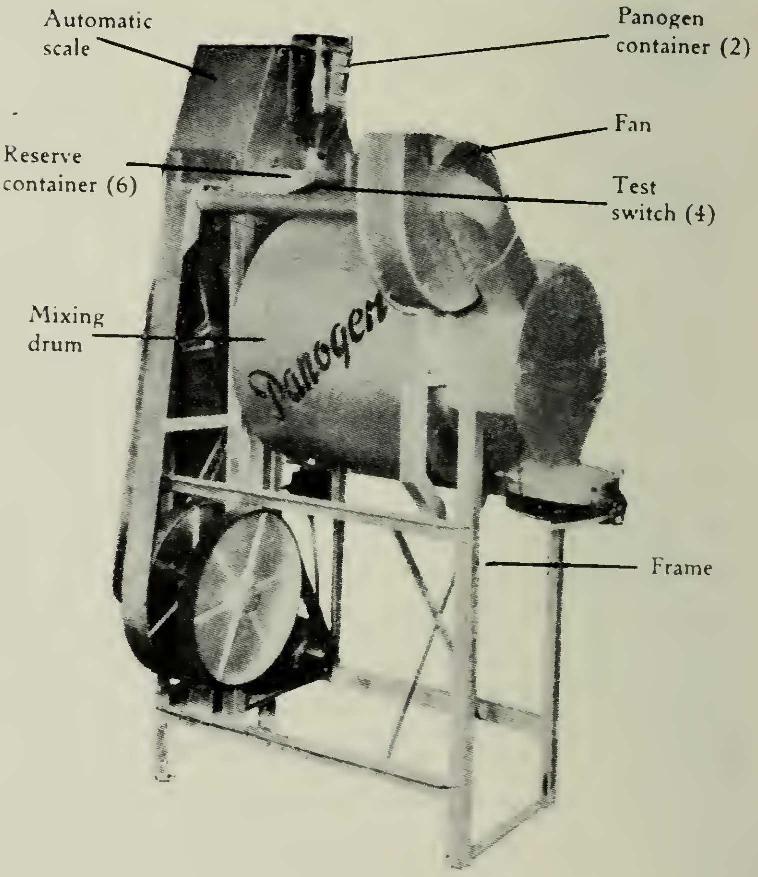
Precautions when using: — *Mercury compounds,* such as Ceresan M, *are poisonous* and must be handled with great care. If used as a dust, it is advisable to treat the seed out of doors or in a well ventilated building. Avoid inhaling the dust, wear a dry cloth or preferably a dust mask over the nose and mouth. Ceresan M has replaced Ceresan.

If the dust comes in contact with the skin wash at once with soap and water. If in contact *with the eyes,* flush with water for fifteen minutes and get medical attention.



KEMP SEED TREATER

PANOGEN SEED TREATER



CARE OF GRAIN AFTER TREATING

After the grain is dusted it should be left uncovered in a pile or in a bin or in open sacks for at least twenty-four hours before sowing. This is sufficient time for wheat, but it is advisable to leave oats and barley for a few days or a week before sowing. Some of the spores of the smut fungus may be under the hull, hence more time is required to kill them. Treated grain may be stored safety for several weeks. If it is stored it should be labeled "Poisonous".

Do NOT feed the treated seed to farm animals. Bags and other containers used for treated seed should be thoroughly cleaned before being used for any other purpose.

METHODS OF TREATMENT

Three different methods are used for treating the grain with mercury compounds.

(1) DUST (2) SLURRY, the chemical is used as a thick liquid, (3) PANOGEN, a coloured liquid. A certain type of machine is used for each of these treatments. See illustrations.

When treating follow the manufacturer's directions.

The amount of grain to be treated may come under two headings:

(a) Large quantities (commercial job), (b) small quantities (individual farmer).

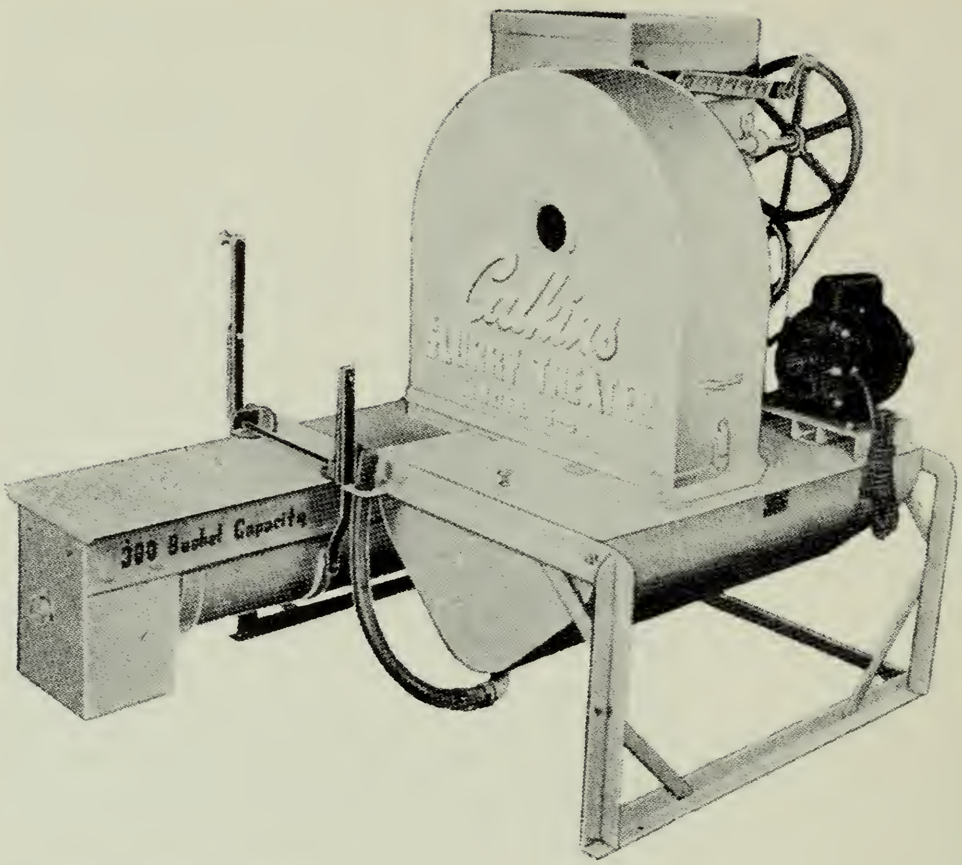
For Commercial Work

Where large quantities of grain are to be treated, one of the following may be used.

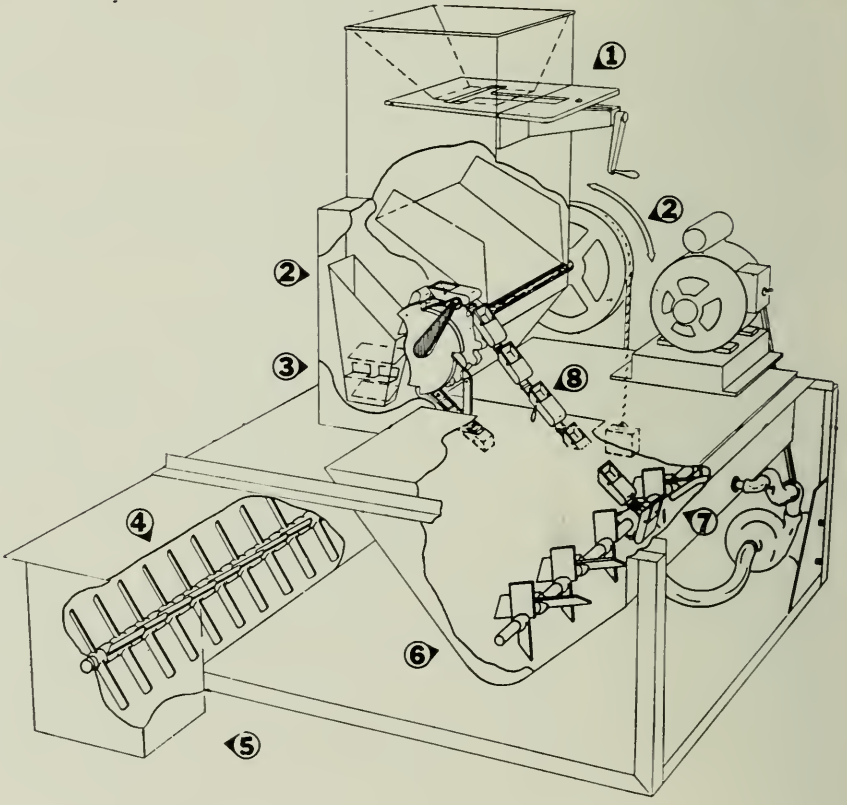
(1) DUST. The Kemp Seed Treater is for this purpose. Ceresan M is mixed with the seed grain. Read "CARE OF GRAIN AFTER TREATING", see above.

(2) SLURRY TREATERS. Two machines are used for this treatment, the Calkins and the Gustafson. For these machines Ceresan M is made up as a suspension in water and the grain is treated with this thick liquid. This avoids drifting of the dust. The treated seed is not damp enough to interfere with drilling, and it may be stored without injury.

(3) PANOGEN TREATER. A coloured liquid is used and it drips on the grain as it passes through the machine. One should be very careful when handling the coloured liquid. Do not allow any of it to come in contact with the skin; if so, it should be washed off at once. This coloured liquid is poisonous and grain treated with it should not be fed to livestock. Panogen treated seed may be sown at once or it may be stored for months.



CALKINS SLURRY SEED TREATER



GUSTAFSON SLURRY SEED TREATER

For the Farmer

The farmer who has a small quantity of grain to be treated and who does not wish to purchase one of the large machines, may use one of the following home made treaters for dusting the grain with Ceresan M.

Before starting to dust the grain, read the paragraph on "MERCURY COMPOUNDS" page 13, also "CARE OF GRAIN AFTER TREATING", and also the instructions on the dust container.

(1) A steel drum holding about 30 gallons is very suitable for treating the grain with dust. See illustrations on page 12. It is fitted with a diagonal shaft which is supported in some manner, either by a frame or by two saw horses, in order that it may be rotated. There should be a mixing board across the drum. This board is fastened at the ends and also to the shaft. The lid of the drum should be dust tight. An old inner tube may be used as a gasket. The grain is put into the drum and the dust, Ceresan M, is added. Use ½ ounce per bushel unless otherwise recommended by the manufacturer. A standard tablespoon slightly rounded holds about ½ ounce. About a bushel at a time can be treated and the drum should be rotated about 20 times. This steel-drum type of treater originated at the Pennsylvania State College.

(2) Another type of treater may be built of lumber. The grain and the dust, Ceresan M, are placed in a hopper at the top and the mixing takes place as the grain passes down through the machine. The Crops, Seeds and Weeds Branch, Parliament Buildings, Toronto, have plans to show the construction of this treater. It was designed at the Minnesota Agricultural Experiments Station.

(3) A cement mixer is sometimes used for treating the grain with dust.

(4) If one prefers to use Panogen in place of dust, he may do so using the steel drum. Put a bushel of seed into the drum, spread the proper amount of Panogen liquid over it, and start rotating the drum at once. Rotate slowly for about five minutes. Follow instructions given on the container. Panogen is poisonous. Do not allow it to come in contact with the skin. Read the section on "PANOGEN TREATER", page 15.

II Formaldehyde (Formalin)

The use of formaldehyde for the control of grain smut is one of the oldest known treatments. Formalin is the commercial name for a 37 - 40% solution of formaldehyde. Formalin may be purchased from drug stores. It may be sold by the pound which is 16 ounces, or by the pint, imperial measure, which is 20 ounces.

FORMALIN SPRAY is often used for the control of oat smut. It should not be used on other grains as it will injure the germination. It is sometimes used for a mixture of oats and barley, but there is likely to be some germination injury to the barley.

Mix a pint of commercial formalin with a pint of water. This quantity (one quart) is sufficient for 50 bushels of oats. A quart or a pint jar sprayer is the most convenient for applying the formalin solution. Treat the grain where there is a good circulation of air, such as on the barn floor with the doors open. If the ventilation is poor, the formalin is very irritating to the eyes, nose and throat.

To do the job rapidly, two men are required. Sweep off the floor and pile the grain on it, then spray part of the floor beside the grain with the formalin solution. As one man shovels the grain into a pile on the sprayed part of the floor, the other sprays some of the formalin solution on each shovelful. The sprayer should be held close to the oats. When finished, spray the bags on the inside and the outside and cover the oats with them. Old blankets, tarpaulin, canvas and such like, may also be used to cover the pile. These coverings should be sprayed on both sides before being placed over the treated oats.

Leave the oats covered for 4 to 8 hours, or overnight, then uncover and they are ready for sowing. It is advisable to spray the inside of the drill also. If it is necessary to store the treated grain for any length of time, it should be run through a fanning mill or otherwise exposed to the air before storing. If stored for more than three weeks there may be some germination injury.

An advantage of this treatment is that large quantities of oats can be treated in a short time, and the grain may be fed to livestock after the formaldehyde fumes have disappeared.

NOTE: No formalin treatment is safe with hulless oats. Formalin sprinkle and formalin dip have been used for the control of grain smuts but these treatments have been replaced by other methods.

(B) HOT WATER TREATMENT

The fungus causing loose smut of wheat and the fungus causing brown loose smut of barley are carried from one crop to the next **within** the seed. For this reason treating the seed with chemicals such as Ceresan M has no effect in controlling the disease. The only means of control is the hot water system and this is very difficult for the farmer to do himself. Hot water treaters have been developed and a new automatic treater has recently been constructed at the Ontario Agricultural College. These treaters are used for large scale operations. A large amount of hot water is required and the temperature must be accurate. If the water is too hot, germination of the grain is injured, if not hot enough, the fungus within the wheat or the barley will not be killed and the treatment is of no value. There is also the problem of drying the grain rapidly after treating.

If possible, secure seed from a field where loose smut is not present.

FAMILY FARM BUSINESS ARRANGEMENTS IN ONTARIO

•

ONTARIO DEPARTMENT of AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 482 NOVEMBER 1951

TABLE OF CONTENTS

●

PREFACE i

INTRODUCTION iii

PART I: **Problems in Organizing and Operating the Family Farm** 1
  Who Should Farm? 1
  Possible Routes to Farm Ownership 2
  The Problem of Securing Farm Capital 4
  Forms of Business Organization 4
  When Should an Operating Agreement Start? 6

PART II: **Sharing the Income and Management of the Family Farm Business** 7
  Pre-requisites to a Successful Farm Business Agreement 7
  The Importance of Farm Records and Good Business Practice 9
  Banking Facilities 10
  Determining the Profit of a Farm Business 10
  Methods of Dividing Family Farm Profits 11
  Drawing Up a Family Farm Business Agreement 16

PART III: **Retirement Plans for Farmers and the Transfer of Farm Property** 20
  When Should a Farmer Retire? 20
  Financial Problems of Retirement 21
  Annuities 23
  Life Insurance 27
  Inheritance Laws and Taxes 30
  Summary 31

APPENDIX A: **Annuity, Amortization, Sinking Fund and Compound Interest Tables** 32

APPENDIX B: **Draft Form of Father-Son Agreement** 34

BIBLIOGRAPHY 39

PREFACE

The family farm has been the predominating type of farm organization in Ontario since the province was settled. "Keeping the farm in the family" has usually been thought a worthwhile objective in the farming community, and many farms in Ontario boast of an unbroken chain of succession through several generations. It is generally considered that this situation is likely to promote greater stability in agriculture, that the productivity of the soil will be better conserved, and that farming as an occupation will be viewed with greater pride and dignity.

Certain changes which have been becoming evident in the economic and social structure of the agricultural industry during the past few years, have caused some concern as to the future of the family farm as a traditional institution. As a result of increasing capital requirements due to mechanization and other factors, particular problems have arisen in connection with the transfer of farm property, and the handing over of the reins of management from father to son. In some cases family farm units have broken up through failure to arrive at satisfactory family business arrangements. In consequence, many a promising young farmer has drifted away from the family farm and out of agriculture, while the father and mother have continued to operate the old homestead long past a reasonable age for retirement, at a diminishing level of output and efficiency. This situation obviously is not conducive to the best use of agricultural resources, either material or human.

The problems associated with getting young farmers established on the home farm, and of enabling the older folks to retire, are, of course, primarily personal and family problems. For this reason they must be approached with tact, and do not, generally speaking, lend themselves to the group approach. There is a growing recognition, however, that Ontario farm people are genuinely anxious to secure assistance in working out sounder and more systematic business arrangements on family farms. This is evidenced by an increasing volume of requests for information and personal counsel.

During the past two or three years the staff of the Economics Department of the Ontario Agricultural College has had the oppor-

tunity to investigate this problem at first hand, to compile information as to its extent, and to study some ways which have been evolved to meet it, both in Ontario and elsewhere. Many family farm business problems have been discussed personally with the parties concerned, and attempts have been made to suggest possible solutions. In the light of this experience, the decision was made to prepare this bulletin. It must be realized, however, that the infinite variety of individual situations makes it impractical to suggest any single formula for solving family farm business problems. Nevertheless there are certain general considerations or principles which seem to apply in the majority of cases. It is hoped that farm people who read this bulletin may secure ideas which may be applied to their particular circumstances.

Credit is due to Mr. A. C. Robertson who has been active in the collection of case material used in the preparation of this report. Many useful comments and suggestions were offered by Professor W. M. Drummond, Dr. N. H. High, Dr. M. W. Farrell and Mr. A. G. Ball. The co-operation of farm people who supplied basic information relating to their own problems and experience is also gratefully acknowledged.

The writer would also like to express special appreciation to Mr. R. B. Freure for assistance in preparing the section dealing with insurance, and to Mr. J. K. Blair for advice on a number of legal matters.

INTRODUCTION

It is not the purpose of this bulletin to argue the case for the family farm. It has been generally accepted as the basic type of operating unit in Ontario, and there is plenty of support for the view that it will so continue. At the same time, it is fairly evident that if agriculture is to compete on equal economic terms with other industries and to effectively utilize modern machinery, the general trend will be toward larger productive units. Otherwise some means will have to be found for co-ordinating and consolidating the operations of a number of smaller family units. It seems quite possible to incorporate both of these objectives within the family farm framework.

It is not necessary to think of a family farm as a small farm. For the purpose of this bulletin, *a family farm is considered as an operating unit in which the capital and managerial ability is supplied by the members of one family group.* It need not follow, however, that the labour be contributed entirely by the members of the family. Normally the bulk of the labour will be family labour, but it is quite possible to have a large, commercial-type of family farm on which over half the labour is hired. At the same time, under another type of farming, and with a high degree of mechanization, a very large unit may be operated entirely by the members of one family. The size of the family, and the proportion of sons and daughters, will of course be controlling factors.

The amount of capital invested in the average family farm has been steadily increasing. This has been primarily due to investment in modern tractors and power machinery, necessitating greater output of field and animal products to carry the overhead. Investments in dairy herds and other types of livestock have increased, both as a result of greater numbers carried, and more attention to quality. Farm buildings, including dwellings, have been improved, electrified and modernized. Land has been drained and improved.

Where the family farm business has been built up over a period of years, it is possible to finance this increased investment largely out of current income, through the re-investment of funds which might otherwise have constituted personal savings. As a result, older farmers seeking to retire have found their life earnings largely tied up in the farm productive plant. Their sons, anxious to take over the farm business, find the capital investment too large in relation to their present resources.

It is a question, of course, if family farms should have to be entirely re-financed each generation. For one thing, the trend of farm prices is somewhat uncertain, and the young farmer unlucky enough to encounter a lengthy period of depressed prices early in his career, is placed under a severe handicap. The fact remains however, that provision must be made for a retirement income for the father and mother. The latter may also wish to make some provision for other sons and daughters who have contributed to the success of the family farm business, only to withdraw from it at some point.

Many of the difficulties surrounding these problems could be avoided through better farm business arrangements earlier in the lives of father and son. *There are in reality two problems to be solved. The first of these relates to the proper division of the farm income while both father and son operate the business. The second has to do with the eventual settlement of the estate when the father and mother retire.*

This bulletin is divided into three parts, corresponding to the three general stages involved in each generation of family farm business. Part I deals with the initial stage, extending up to the time when the son reaches maturity and is married. Part II then discusses possible arrangements for sharing the income and management of the farm during the important period when both father and son are active farmers. Finally Part III considers ways and means of enabling the parents to retire, and methods whereby the farm property may be passed on to the next generation. The Appendix contains a draft form of Agreement, together with some useful investment tables.

It is not possible in a bulletin of this length to discuss fully all possible legal complications involved. *When the time comes for drawing up a working agreement, a will, or a farm purchase contract it is advisable to seek legal advice, to ensure that all parties are properly protected.* Preliminary to this step, however, careful thought and discussion should take place as to the fairest and most reasonable course of action. The solicitor should not be expected to suggest the complete plan of action. Rather he can advise how your proposals may best be carried out.

Part of the difficulties which have developed on some family farms trace to a reluctance of family members to discuss business arrangements frankly. Sometimes a third party is required to bring the parties together and effect a settlement, but often this does not take place until complications have arisen. More frequent family discussions leading to businesslike agreements would pave the way for the removal of much uncertainty and misunderstanding.

FAMILY FARM BUSINESS ARRANGEMENTS IN ONTARIO

H. K. Leckie[1]

PART I

Problems in Organizing and Operating the Family Farm

Who Should Farm?

One of the fundamental questions which must be settled at some point in the life of every farm boy is: "Will I be a farmer?" His decision may not have to be arrived at suddenly, nor need it necessarily be final and irrevocable. Nevertheless the question must be faced squarely. Usually the final decision can be postponed until the end of one educational phase, possibly matriculation, or even till college graduation. The farm girl, too, must make a similar decision, but this may come at the time she is faced with the choice of a life partner.

The decision to farm, or not to farm, is no matter for snap judgment, any more than is the choice of other occupations. Not all farmers' sons are by aptitude or temperament fitted to become farmers, any more than are all doctors' sons natural-born doctors, or all engineers' sons potential engineers. History records many successful men of varying occupations who left the farm in favour of other careers.

There is some evidence to show, however, that a higher proportion of farmers' sons do follow in their fathers' footsteps, than is the case with many other occupations.[2] This is probably natural, since the farm boy receives in his youth an apprenticeship in farming, and is continually in contact with farm people and the farm business. The existence of a going concern close at hand in many cases makes the succession to the family farm seem a natural and logical objective.

There is no doubt that the parents exert a major influence in deciding whether their children shall choose farming as a way of life. Where the father is a successful and proficient farmer, has developed a wholesome philosophy of rural life, and is able to impart this knowledge and enthusiasm to his son, there is more likelihood that the boy will follow in his footsteps. The mother too, may be a very important influence in moulding her children's attitude toward farm life. If she is happily adjusted to it, there is every possibility that her attitude may be contagious. On the other hand, the children of non-progressive or dissatisfied farmers are less likely to choose to stay on the farm.

Nowadays a good many people are heard deploring the migration of farm young people to urban centres. Actually the mere fact that young people are leaving farms is not in itself alarming. Increasing efficiency in agricultural production and greater output per man, make it inevitable that fewer farmers will be needed to furnish the world's food supplies. A continual reduction in the proportion of people employed in agriculture is characteristic of the most progressive countries. The destructive effects of uneven rural depopulation on rural institutions, however, and the possibility that too high a proportion of the ablest rural youth is migrating to cities, pose more serious questions that merit further study. Farm opportunities and rural life must appear increasingly attractive to ensure the retention of a good proportion of the brightest and

---

[1] Formerly Professor of Agricultural Economics, Ontario Agricultural College.

[2] See "The Transmission of Farming as an Occupation", by W. A. Anderson, Bulletin 768, Cornell University, 1941.

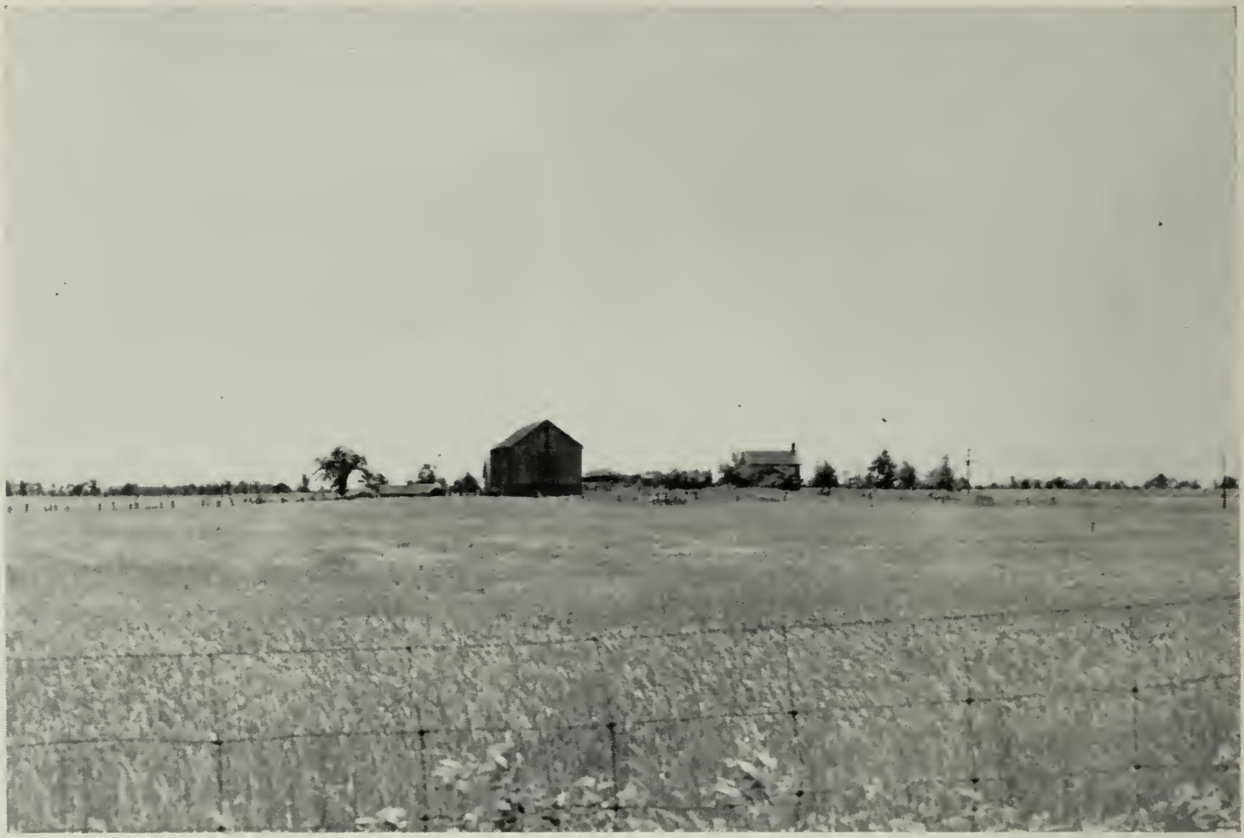


FIG. 1. Some farms do not readily lend themselves toward expansion necessary to support two families adequately. Note the leaning chimney, the thin wheat and the weeds.

most energetic farm young people within the industry. Otherwise the farm population may drift into progressive mediocrity.

A young farmer who has chosen his occupation advisedly, after considering possible alternatives, or even after trying his hand at other jobs, is likely to be more successful and contented, than one who takes the line of least resistance, and farms simply because his father has farmed. The latter may not have much liking or aptitude for his job, and may harbour an unrealized ambition to seek other fields. Failure to conclude satisfactory financial arrangements is often a further source of dissatisfaction and uncertainty.

Possible Routes to Farm Ownership

In arriving at the important decision to choose farming as a life work, and with complete ownership of a farm business in mind as the eventual goal, there are a number of possible alternatives open to the farm boy. Among the more important of these are:

(1) Staying on the home farm, sharing in its income during the active life of the father, and eventually taking over ownership and management of the business.

(2) Leaving the home farm, working for hire on other farms to accumulate experience and capital, and eventually organizing a new farm business, possibly at first on a rental basis. This has been called the "agricultural ladder".

(3) Leaving the home farm to seek employment in urban industry, with the idea of accumulating capital to resume farming later, on

the home farm or elsewhere. This is a more modern style of "agricultural ladder".

Of the foregoing possibilities, the first has been the most popular and is still desirable in the majority of cases. Land which remains in the family name continuously is likely to be better farmed. Associations in the home community are not broken. Where the son takes over the home farm, the retirement problem for the parents may be simplified. In addition, the problem of capital accumulation for the son may be less formidable, if proper business arrangements are worked out at an early stage. Taking over the family farm as a going concern by degrees can be accomplished with less of a financial burden than if a new business is built up from scratch. Also it is a source of satisfaction to parents to see the farm business carry on and prosper.

Under certain circumstances, however, it may not be feasible or desirable for the farm boy to remain at home. This is particularly the case where there are a number of sons, and the family farm business cannot be expanded to the point where there is sufficient income for all concerned. Again, the type-of-farming to which the home farm is adapted may not suit the aptitudes of the boy. For example, if he is primarily interested in mechanized cash-crop farming and dislikes handling livestock, he will not be entirely happy on a home farm which is rolling, has conservation problems, and is primarily suited to dairying or other types of livestock production.

It may also happen that personalities clash. Where there is some source of deep-rooted family friction or discord which cannot be easily overcome, leaving the home farm may be more desirable than remaining in an environment of non-cooperation and bickering. It is fortunate, however, that these conditions are the exception, rather than the rule. A more common situation is the one where the son feels he is not given sufficient opportunity to develop his own ideas and initiative. Admittedly it is difficult to have two managers for a farm, as in any other business. But the junior partner needs training in making important decisions and in abiding by their results. Sometimes activities outside the home farm, such as custom work, may provide good experience.

At one time, the "agricultural ladder", whereby one progressed up the scale from hired man, to tenant, to owner, was a common route to farm ownership, especially in the case of larger farm families. Today the relatively large amounts of capital required to start farming, the scarcity of good farms to rent, the high cost of living in relation to farm wages, all make the ascent of the ladder extremely laborious. While working on a variety of up-to-date and progressive farms adds considerably to the breadth of farm experience, the higher wages usually offered in some lines of urban employment may provide greater opportunity to accumulate savings. The city-job approach may also help to settle any doubt as to whether rural or urban life is the more desirable alternative. It also may be a broadening influence in personal development and character building.

There is always the chance, of course, that the young farmer who takes up urban employment, presumably on a temporary basis, or who registers for an agricultural college course, will eventually decide not to resume farming. At the same time, he may also get a bit rusty from the standpoint of practical farm experience and management. These are inevitable hazards, but a deep-rooted love of the land and a genuine desire for country life will surmount them.

All things considered, there seems little doubt that taking over the home farm affords that most desirable route to farm ownership for the average farm boy, provided that the number of sons in the family is not too large, that the farm is of suitable type, that there is a spirit of mutual co-operation and confidence, and that the son and his wife have definitely chosen farming as their occupation. Having made this choice, however, is not enough. Certain business arrangements must be worked out, to ensure equitable treatment for all concerned.

The Problem of Securing Farm Capital

One of the stumbling blocks in starting and operating any business venture is always the lack of sufficient capital. In pioneer or homesteading days it was possible to start a farm business with a minimum of capital. A strong constitution and a stout heart were the essentials. Today, farming is becoming more and more a business involving a substantial capital investment. At the present time in Ontario the total inventory on most family farms, including real estate, stock and equipment, ranges from $15,000 to $30,000, with a good many approaching the higher figure. To start farming from scratch, requires possession or control of at least sufficient capital to make the required down payment on the farm itself, to purchase a nucleus of breeding stock, and to secure the most essential machines. Staying on the home farm, however, avoids the necessity for a large initial capital investment by the son. Nevertheless there should be some definite financial plan whereby he may gradually build up his equity or ownership claim in the farm capital. At the same time the father should be placed in the position where his savings may be withdrawn by degrees from the business to provide a retirement income. The transfer of title to the farm property itself (which represents the "fixed" capital) may be arranged by a variety of plans which will be discussed in greater detail.

Failure to understand the nature and functions of farm capital, and the necessity for someone to retain considerable savings in the business rather than in government bonds, insurance, annuities, or other investments, may often be the source of misunderstanding among farm families. The lack of suitable farm business records is usually a contributing factor.

Forms of Business Organization

In the business world, certain fundamentally different forms of organizing and operating a business have come to be recognized. These include:

(1) The sole proprietorship
(2) The partnership
(3) The corporation or joint stock company
(4) The co-operative
(5) The state-owned enterprise

While examples of farms operated under all of these forms of management may be found in Canada, most farms in Ontario fall into the first-named category. Many so-called "father and son partnerships" do not exhibit all the characteristics of a legal partnership.

The provisions of the Ontario Partnership Act[3] are too numerous to permit full discussion here. Briefly partnerships may be defined "as the relation which subsists between persons carrying on a business in common with a view to profit". The relationship is usually defined in detail in a document known as the "articles of partnership", which sets forth such facts as the term of the agreement, the nature of the business to be carried on, the contributions to be made by each partner in the form of capital or personal services and the way in which profits shall be distributed. This agreement is signed by the partners, witnessed and registered in the public registry office. Until the partnership is dissolved, either by mutual consent, by the death of a partner or for other reasons, the agreement continues in force.

---

[3] For further information see the Revised Statutes of Ontario, (1937), Vol. II, Chap. 187.

Among the important features of a partnership, which should be understood by anyone contemplating entering such an arrangement, is the fact that any partner may act as an agent for the firm. This means that a partner may buy or sell in the name of the firm, and bind the firm by contract. There are, however, some limitations to this authority, and it is quite in order to insert in the partnership agreement, reasonable restrictions on the power of any partner to bind the firm. For example, it might be provided that consent of all partners be required in transactions involving a sum of money in excess of a certain amount.

Should a partnership incur losses, or eventually fail, all partners must assume full personal liability, in the same way as if each were in business for himself. That is, each partner is liable, not only to the extent of the capital he contributes to the partnership, but also to the extent of his personal wealth.

It is not correct to assume that a partnership cannot be said to exist without a written and recorded partnership agreement. Neither is it true that the sharing in the earnings of a business by two or more people automatically makes them partners. Thus the fear of possible legal implications of partnership should never deter a father and son from drawing up a formal agreement relating to the method of sharing the income of the family farm business. But it does suggest the desirability of securing expert counsel and advice in arriving at a type of agreement which best fits their particular circumstances.

Corporations possess some advantages over partnerships. One is that each shareholder in a corporation is only financially liable to the value of the shares of stock which he holds. Thus the corporation may itself become insolvent, while the individual shareholder's wealth, outside of his investment in stock, remains intact. Another fact is that the corporation is an artificial person or "entity" distinct from its stockholders. Thus when one stockholder dies, his shares pass to his legal heirs, and the company's existence is unaffected. Any profits of a company are, of course, distributed in proportion to the number of shares of stock held.

Not many farm businesses are of sufficient size or complexity to warrant the formation of a private corporation. However, there are undoubtedly exceptional cases where this might be worth considering, particularly if there are a number of children, and if the estate is large and would involve heavy succession duties.

To set up a family farm corporation in Ontario, it would be necessary to incorporate under either the Dominion or Ontario Companies' Act. This would involve submission of an application for a charter to the Secretary of State at Ottawa, or to the Provincial Secretary at Toronto, setting forth the details of the proposed undertaking, including the capitalization. Legal assistance would probably be desirable, and there would be some expense involved.

The co-operative form of organization is becoming increasingly familiar to farmers, particularly in the field of marketing farm products or in the purchase of farm supplies. As yet there is limited experience in the co-operative operation of farms. Co-operatives differ fundamentally from corporations in the methods of management control and in the manner of distributing "profits". Actually the use of the latter term is usually frowned upon by co-operatives. Any excess earnings accruing to co-operatives are distributed on the basis of the amount of participation in services performed by the co-operative, rather than in relation to shares of stock held. In addition each co-operator has equal voting power in electing the board of directors, while in a corporation control rests with those holding the majority of stock.

To form a farm co-operative in Ontario it is necessary to obtain a charter under a special section of the Companies' Act, a procedure somewhat similar to that required to organize a joint stock company. Like corporations, farm co-operatives probably are worthy of consideration mainly in the case of exceptionally large farming enterprises.

Most family farms in Ontario, therefore, will continue to operate as individual proprietorships or informal partnerships. But there is evidence of the need for more widespread use of definite family business agreements where fathers and sons combine forces in running the business. In quite a few cases formal partnerships may be desirable, particularly where two or more brothers operate a single farm enterprise jointly. In even more complex cases, a private company or co-operative may be in order. In any event a greater understanding of the financial and legal aspects of each form of business organization would be highly desirable, to ensure a more systematic and orderly conduct of family farm business affairs, and to provide greater encouragement for young men starting to farm.

When Should an Operating Agreement Start?

The most opportune time to consider drafting a family farm business agreement will of course vary with circumstances. There is no reason to delay after the son has reached maturity of thought and judgment, and has definitely decided to stay on the home farm. The marriage or prospective marriage of the son may often bring matters to a head, but there are sound arguments for beginning an agreement while he is still single. This may put him in a better position to advise his future partner of his prospects and removes the grounds for possible misunderstanding later on. If necessary, the terms of the agreement may be altered as circumstances change.

The farm business agreement should of course envisage the *joint operation of the whole farm business.* As a preliminary, while the boy is still in his teens, club projects in various farm enterprises often provide valuable training and experience. But, generally speaking, family farm business agreements which provide for the son to receive all or part of the net income from individual farm enterprises only, are not very satisfactory. They create a danger that certain jobs will receive the most attention, while others will be neglected. Each co-partner should have a stake in the *whole farm business*, and *all* income and expenses should be pooled.

In some cases the practice has been for fathers to pay their sons a wage, particularly while the boys are still attending school, or are not sure what their future plans will be. This is probably more desirable than an indeterminate allowance from the father's pocket, since it provides training in budgeting and saving. Working for wages on the family farm, however, is a poor substitute for joint proprietorship. Even in the case of hired labour, various types of "incentive" plans have been developed, to provide a closer relationship between wages and farm profits.

It should be realized that the son cannot legally bind himself under a formal contract before he is twenty-one. However, it may often be desirable to draw up a family farm business agreement while the son is still a minor provided that he is sufficiently mature, and realizes that the contract may become binding when he reaches twenty-one. It might, however, be wise to defer the transfer of any farm property from father to son, as part of an agreement, until the son has attained his majority.

PART II

Sharing the Income and Management of the Family Farm Business

In the majority of cases where it has been decided that a son will stay on the home farm with the idea of carrying on the business, it will undoubtedly be found that there will be a gap of a few years between the time the son reaches maturity and the date at which the father feels inclined to retire. In this intervening period both father and son are able to participate actively in the operation of the farm business. It is therefore important that a plan be agreed upon so that it will not be a "one-man" business, but a family partnership in which both the management and income are shared on a definite and pre-arranged basis.

Pre-requisites to a Successful Farm Business Agreement

The mere act of drawing up and signing a business agreement between father and son is no guarantee that all problems will vanish overnight. Certain other conditions contribute equally to the success of the joint undertaking. Among the points to be checked are the following:

(1) Have the son (and his wife) a real desire to take over the family farm?
(2) Is there suitable living accomodation for two families?
(3) Is there a bond of mutual confidence and co-operation between father and son and a belief that a partnership is desirable and workable?
(4) Can the farm business, under good management, produce a satisfactory living for two families?

Unless the foregoing questions can be answered "yes" there is not much possibility of arriving at a satisfactory and lasting agreement. It is important that the son really feels he wants to be a farmer, and is not being forced into the job by the rest of the family. His wife must also feel that his and her talents are not being wasted on the farm.

The necessity for providing suitable living accommodation cannot be stressed too much. As a general rule this means either separate houses on the farmstead, or, if the original dwelling is large, and lends itself to subdivision into two self-contained units, this may be a satisfactory alternative. Either of these plans avoids having "too many cooks spoiling the broth" and removes much of the possibility of petty annoyances between the respective households. At the same time there is the opportunity for close association.

It is of course desirable that both farm families have the opportunity to enjoy equally comfortable and modern home conveniences. If an additional house is built for one of the families, it does not necessarily have to be as large or of as elaborite construction as the original dwelling, but the same general facilities should be provided.

Basic to all farm partnerships is a financially successful farm business, with an income sufficient to maintain at least the two families. No matter how fairly the income shares are divided, there will be dissatisfaction if the total earnings are too low. It may be necessary to revamp and extend the present farm management plan to provide more income. This may involve heavier stocking or higher grade stock, the use of more intensive cropping practices, or may even suggest the renting or purchase of additional land. There will come a time, however, when the father may wish to slack off a little and take life easier. At this stage he may not wish to undertake heavy capital investments

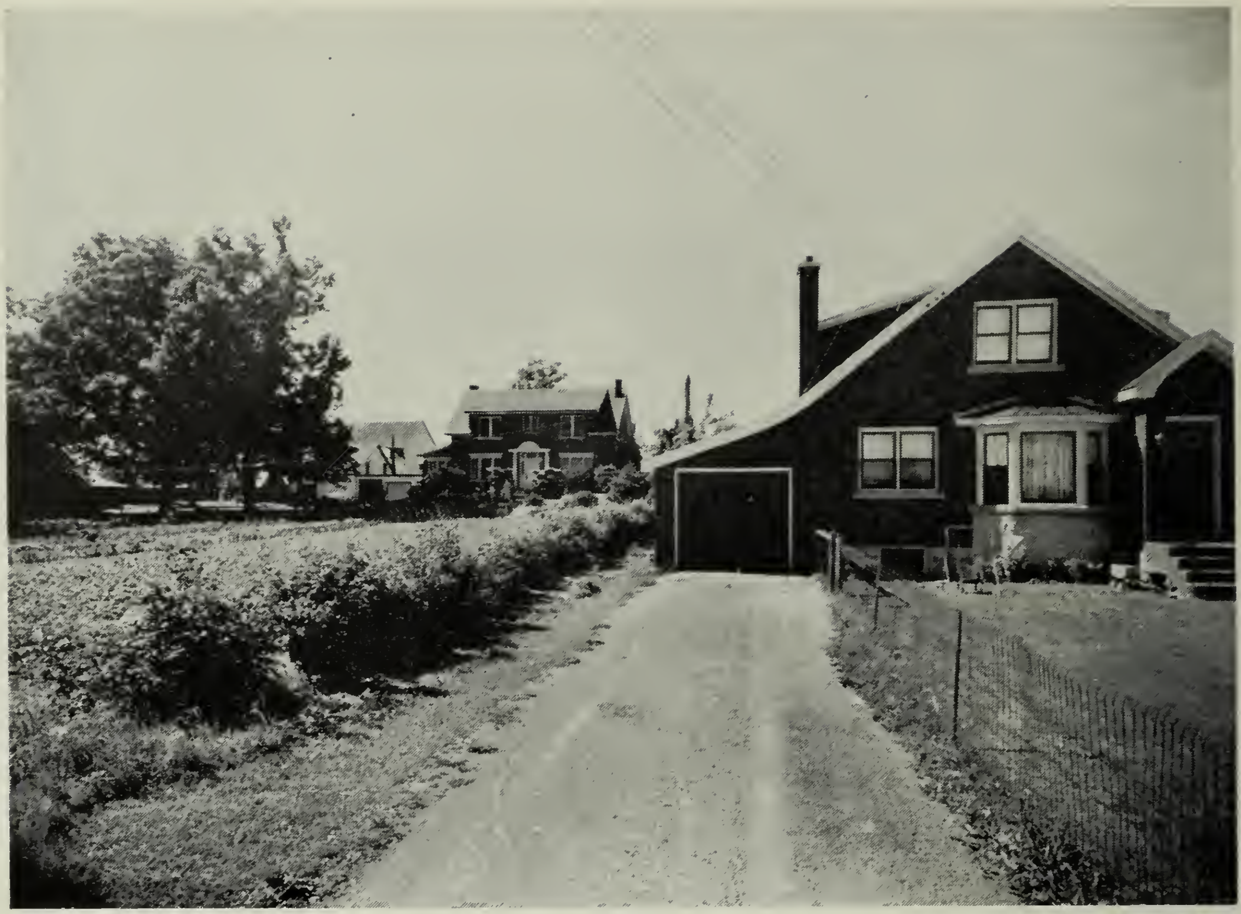


FIG. 2. This is an attractive Ontario Farmstead. The father and one son live in the large house while another married son lives in the house in the foreground. The farm business is built around dairy cattle and poultry.

in the farm business. For this reason the son should not try to push the expansion of the business too far, unless he is prepared to hire extra labour, or has a growing family of his own to provide additional help, and can furnish the necessary capital.

Probably the most essential requirement of all for a successful father and son partnership, lies in the personal bond which must exist between the two parties. The son must respect his father's mature experience and judgment, and not be too impatient with what may appear to be conservatism in adopting "new-fangled" ideas. On the other hand, the wise father will realize the folly of trying constantly to exert a veto power over the son's managerial suggestions. In too many cases the son is never given sufficient responsibility in making decisions or in transacting farm business. As a result, on his father's demise, he is apt to be ill-prepared to run his own show. The results may often be disastrous.

Partnerships always involve a certain amount of "give and take". They simply will not work if each partner is bound to have his own way at all costs. This does not mean to say that at times there will not be honest arguments and disagreements. However, it does involve a readiness on the part of both father and son to discuss all angles of a problem fully, whether it be the purchase of a new herd bull, or the possible change-over to a new system of handling hay. Where there is wide disagreement, it is usually wise to seek more information and advice from well-informed and disinterested outside parties, such as the

FIG. 3. Due to the increasing amount of capital needed in the farming enterprise adequate records are essential. This farmer has a good place in which to keep his records.

county agricultural representative, other progressive farmers, or the agricultural college. Once the decision has been made in the light of the best information available, it should be cheerfully accepted by all concerned and acted upon.

The Importance of Farm Records and Good Business Practice

For many years the argument has gone back and forth as to the actual dollars and cents value of farm records to the operator. It is now pretty generally agreed that reasonably accurate accounts are invaluable in the management of the farm business. Even so, many an experienced farmer who has always had, or who has developed, a good business sense continues to get along without a very elaborate accounting system. The reason often is that he lets his bank do most of his financial accounting, and is not interested in separating out the details of his farm business from personal and household expenditures. At the end of the year he does know how much farther ahead or behind he is financially in terms of the bank account. But he may not know very accurately his true net worth, or whether any extra money he may have in the bank results from increased farm profits, decreased family expenditures, or merely from the sale of capital assets.

When it comes to partnerships, however, there is no argument as to the necessity for farm records. These must be sufficiently accurate to account for all sources of farm income, and to show in detail the amount and purpose of all expenditures. The individual proprietor in business who keeps no records knows that whatever surplus remains at the end of the year is his. Where several members of a business firm receive money, or pay it out, it is easy to see what a muddle would develop if there were no systematic accounting.

All farm business agreements, therefore, depend on the maintenance of a suitable farm account book[1] containing:

(1) An accurate record of all farm receipts and expenditures, preferably broken down into suitable categories, or by enterprises.
(2) A complete inventory of all farm property taken once a year, preferably on January 1st, denoting ownership claims.
(3) Any other useful information considered desirable, such as the annual crop record, livestock production records, etc.

Where records have been maintained over a period of years, it is generally easier to arrive at a fair basis for starting an operating agreement. The average income and expenditures of the farm business under the previous plan of operation and management will be known, and the value of the farm capital used in the business will be recorded. However, a record-keeping system may be started at any time, and if not already set up, the commencement of a family business agreement provides a suitable opportunity.

Banking Facilities

As well as the keeping of records, partnership agreements require businesslike methods for handling receipts and expenditures of cash. Probably the simplest way to keep things straight is to open a joint farm bank account. This may be of the type known as a "current" account. All income in the form of cash or cheques should be deposited in this account by either party as soon as possible after it is received. All farm expenditures, except petty items, should be paid by cheque. Items paid for in cash should be supported by receipts or other vouchers, and settled at intervals. In addition to this farm business account, each partner in the firm should maintain his own personal savings account. Regular monthly withdrawals from the joint farm account by each partner may be agreed upon, with a final settlement at the end of the year.

Under this system, where a farm account book is maintained, and where a farm bank account is used as a further check on revenue and expenditure, there should be no difficulty experienced in keeping the finances and business records of the family farm in good shape. A few minutes spent in bookkeeping each week should be ample.

Determining the Profit of a Farm Business

When is a farm business profitable? This may well be the "sixty-four dollar" question. But it is a question which can be answered fairly readily, if the meaning of the word "profit" is clearly understood. Different people use the term "profit" to mean a good many different things.

One way of defining profit is to say that it is the amount by which the total income of a business exceeds the total expense of running it. This requires one to explain further what is meant by "income" and what is included as "expenses". The first part of this task is fairly easy. Income in any business results from the sale of goods or services. Thus in a farm business, income includes the revenue from the sale of farm products, receipts from custom work, prizes, services rendered off the farm and from any other similar sources.

Expenses are generally regarded as the costs of acquiring income. This seems simple enough. But the catch comes when we try to track down all of the costs associated with earning the income of any particular period. Some items such as feed, seed, fertilizer, labour, repairs and taxes re-occur regularly each production period, while investments in new buildings, machinery and breeding stock are made only at intervals. It is the usual practice to term the former "current" expenses, and the latter "capital" expenses. It is obviously not proper to charge capital expenditures against the one year's operation in which they occur, since capital assets help to earn income over a period of years. Machines or buildings eventually wear out or become obsolete, and must be replaced, however, so it is good practice to recover part of their cost out of income each year. The portion of their cost charged as an annual expense is termed *depreciation.* Land is not normally "depreciated" on the theory that with proper use it will not wear out, or lose its productiveness although this can be a subject for debate.

---

[1] The Ontario Farm Account Book is available free to Ontario farmers who request it from the Economics Department, O. A. C., or County Agricultural Representatives' Offices.

A farm business therefore, may be said to earn a profit when:

(*a*) All current operating expenses are paid, including interest on borrowed capital, but not principal payments.

(*b*) Depreciation on buildings, machinery and breeding stock is provided for, and soil fertility has been maintained.

If the farm income is sufficient to meet these two basic requirements, the balance may be considered the operating profit, belonging to the owner-managers. It will be noted, however, that if so determined, the profit or net income in reality includes the salary or wages of management, interest on the owner's capital investment, and possibly a small balance to compensate for risk and managerial initiative. It is possible, therefore, that if the manager pays himself a salary as good as his ability might command elsewhere, and expects a return on his capital investment as high as it might earn elsewhere, there will be no "pure profit" remaining at all.

As long as there is only one farm operator, it is not of great concern to him whether the balance remaining after all expenses are paid is thought of as salary, interest or profit. Nor is it so essential that he distinguish carefully between current and capital expenditures, except possibly when preparing his income tax returns.

When there are two or more partners involved, however, it becomes more important to determine accurately how much true "profit" is available for sharing at the end of the year, and by how much the net worth of the business has changed as a result of the year's operations. This requires that there be agreement as to what constitutes income, and what will be included as operating expenses.

In the field of farm business management, the amount remaining after total farm expenses are deducted from total farm receipts, is termed the *farm income.* Then a further deduction of interest on the total farm investment at the going rate results in what is called the *labour income.* To this is added the value of farm produce used on the farm, or perquisites, to ascertain the operator's *labour earnings.* Actually the *farm income plus the perquisites* would compare most closely with the small businessman's idea of "profits".

Methods of Dividing Family Farm Profits

Where father and son operate a farm business jointly, the question arises as to the basis for dividing their yearly profits, or net income. The most reasonable theory seems to suggest that the division should be made in proportion to the contributions each party makes to the firm, whether in the form of labour, managerial ability or capital. Since the son is normally in the position of entering a business already established, and in possession of little or no capital of his own, he obviously should not expect to receive a major share of the net income at the start.

To calculate the approximate share due to each partner, it is necessary to agree on certain fundamentals, such as:

(1) The present value of the farm, stock and equipment.

(2) The rate of interest to be allowed on the capital investment represented by the farm property and the work stock.

(3) The value of each partner's services to the farm business in the form of labour and management, taking experience, health and other factors into consideration.

For example, let us say that a farm inventory is valued at $22,000, made up as follows:

Real estate	$11,000
Livestock	5,000
Machinery and equipment	4,000
Feeds and supplies	2,000
Total	$22,000

We will also assume that the father contributes all of the farm capital,[2] and that both father and son work on the farm twelve months of the year. It is further understood that an interest rate of 4½ per cent per annum shall be allowed on capital, together with a nominal wage rate of $100 per month for both father and son.

In these circumstances, the contributions of each partner to the farm business are as follows:

Father				
Farm Capital – $22,000 at 4½%	=	$ 990.00		
Labour and management, 12 months at $100	=	1200.00	$2190.00	(65%)
Son				
Labcur and management, 12 months at $100	=		$1200.00	(35%)
Total Contributions			$3390.00	(100%)

On this basis the net income would be divided in the ratio of about two thirds to the father and one third to the son, since this is the proportion of their contributions. Because the father owns all the capital assets, he must allow for depreciation and major improvements on them out of his income share. Minor repairs, taxes and insurance would generally be included as operating expenses in calculating the net income.

Now suppose in the previous case, the circumstances were that the father held the deed to the real estate, but there was a mortgage of $3000 outstanding. Moreover, let us assume that the father and son jointly owned the movable capital (livestock, equipment, feed and supplies), valued at $11,000 in total. The contributions of each party will now be:

---

[2] In this illustration it is presumed that there is no real estate mortgage against the property. If there were, the father would really contribute only the value of the farm less the mortgage.

Father

Fixed capital – $8,000 at 4½% = $ 360.00
Movable capital – $5,500 at 4½% = 247.50
Labour and Management – 12 months at $100 = 1200.00 $1807.50 (55%)

Son

Movable capital – $5,500 at 4½% = $ 247.50
Labour and Management – 12 months at $100 = 1200.00 $1447.50 (45%)
Total Contributions $3255.00 (100%)

Under these conditions the son's percentage of contributions, and his share of the income, rises to 45 percent, while the father's declines to 55 per cent. The interest payment on the mortgage will of course be chargeable as an operating expense, and there will have to be an understanding as to the method of retiring the mortgage. Since the machinery is jointly owned, depreciation on it will be assumed jointly, by deducting it in calculating the net income.

It is desirable in most cases for the son to get into the position of contributing at least half the movable capital in the farm business as soon as possible. There are several reasons for this, over and above the fact that his contributions, and therefore his share of the income, will be greater. In the first place, the problem of ownership of the natural increase in livestock is simplified. Each owns a half interest, and therefore all revenue from livestock, and all inventory increase, may be shared equally. It is probably better that father and son each own a half interest in the whole herd, rather than attempt to break down the ownership by individual animals. When new breeding stock is purchased, payment may be made from the farm account. While this does create some problem if either party decides to withdraw from the business, there are various ways in which the ownership claims may be equitably divided.

Joint ownership of the movable capital also simplifies the problem associated with the purchase and upkeep of farm machinery. Repairs, major overhauls and depreciation will all be shared equally. Where one party owns all the machines, there is always the problem of distinguishing between "ordinary repairs" and "improvements", thus leaving room for argument as to the correct method of calculating the net income.

All things being considered, it is recommended that the son agree to buy out a half interest in the movable capital right from the outset, particularly if he is at least twenty-one years of age. This will necessitate a careful appraisal of all livestock and equipment, and agreement as to a fair value of a half share. If the son has worked at home for several years, the father may wish to make some gifts or concessions to him at this stage.[3] Then suitable arrangements may be made for the son to buy out a half-interest from the father through a series of notes maturing yearly. As new equipment is purchased, the cost is shared equally.

If the father retains title to the real estate until his retirement, which is usually desirable, there is the question of who should bear the expense of permanent improvements to the land and buildings. Ordinary repairs may of

---

[3] At the present time gifts up to $4000 annually may be considered exempt from taxation. Check most recent tax regulations.

FIG. 4. Joint ownership of a productive herd of livestock provides an excellent method for the son to acquire an equity in the farm business. In ten years this son built up a valuable herd of dual-purpose cattle.

course be charged against current revenue, but if the son wishes certain improvements made, with the expectation that the property will some day be taken over by him, it is reasonable to assume that he should share the capital cost. Also if there is a mortgage against the farm, the son may agree to assume responsibility for the amortized payments,[4] thereby building up his equity in the business. This will also entitle him to a larger share of the profits, since his contributions are increasing. The agreement should provide scope for these possible arrangements.

Where there are two or more sons involved in the farm business, exactly the same principles apply as in the case of a single son, insofar as the division of income is concerned. True there are more people concerned in making decisions and handling money but fundamentally the general principles of drawing up a business agreement remain the same.

The following hypothetical example may serve to illustrate the possible procedure where a father and two sons operate a 250 acre farm jointly. Suppose the farm inventory in the account book shows the following capital distribution:

Land and buildings	–	$18,000
Livestock	–	8,000
Machinery and equipment	–	4,500
Feeds and supplies	–	2,500
Total		$33,000

---

[4] The "amortization" of a mortgage refers to a plan for paying back the principal and interest in equal annual instalments. The proportion of principal to interest in the yearly payment increases each year. (See appendix, table 3).

Assume that there is a "home" farm of 150 acres, free of indebtedness, with a substantial brick house suitable for two families. The "other" farm, of 100 acres, lies across the road and has a good set of buildings. There is a mortgage of $3500 at 5% outstanding against this property. The boys have just recently completed high school, so they have no appreciable savings of their own.

The movable capital in this case, as represented by livestock, equipment and supplies is valued at $15,000. Thus a one-third interest for each son would require an investment of $5000. Since they have no savings accumulation to start, they would agree to pay the father for their shares in suitable yearly instalments, out of the farm income.

Assuming that this plan is followed, the contributions of each party would be:

Father				
Fixed capital $14,500 at 4½%	=	$ 652.50		
Movable capital 5,000 at 4½%	=	225.00		
Labour and Management,[5] 12 months at $125	=	1500.00	$2377.50	(45%)
Elder Son				
Movable capital $5000 at 4½%	=	225.00		
Labour and Management, 12 months at $100	=	1200.00	1425.00	(27½%)
Younger Son				
Movable capital $5000 at 4½%	=	225.00		
Labour and Management, 12 months at $100	=	1200.00	1425.00	(27½%)
Total Contributions			$5227.50	(100%)

On this basis, the father's share of the net income would be 45 per cent, with 27½ per cent going to each son. Had the sons not taken over a one third interest in the movable capital, their shares would have amounted to only 22½ per cent each, with the father's amounting to 55 per cent. Assuming that the net income from the farm business amounted to $8000, the sons' shares would each be increased by $400 as a result of their full one third participation. Thus they could afford to pay off their indebtedness to the father at the rate of $400 per year without being worse off financially, and at the same time be building up their equity in the farm business.

The interest on the $3500 mortgage on the "other" place would of course be treated as a current operating expense. Any payments of principal would, on the other hand, represent capital expenditure, and it would have to be agreed as to who should take on this investment. This would be associated with the problem of the disposition of the estate, and the question of the brothers eventually setting up separate farm units, or continuing to combine operations after the father's retirement.

It would be essential in a family arrangement of this kind to maintain the farm income at the highest possible level, consistent with sound management, since there might, for a considerable period, be three families dependent on the success of the farm business, and two following the parents' retirement. The development of a maximum volume of business in relation to the capital investment is characteristic of all well-managed farm enterprises, but extremely important in this type of situation.

---

[5] It has been assumed in the illustration that the father's experience will at the outset entitle him to a little extra yearly salary, As the sons mature this differential may be equalized.

Drawing Up a Family Farm Business Agreement

The preliminary step to any business agreement, even if it is to concern members of one family group, is a conference or series of conferences to discuss the necessary details. There are usually a number of small differences of opinion which must be ironed out or compromised at the start. Members of the family should have a frank discussion as to possible arrangements for joint operation of the farm business, the provision of suitable living quarters, and other matters. It may also be desirable at this point for the parents to make some suggestion as to their future plans for retirement, and their general thoughts or wishes respecting the transfer of the property and the disposition of the estate.

If these preliminary discussions are satisfactory and indicate a mutual desire on the part of all parties to work out a suitable business plan covering the operation of the family farm, the task of preparing a draft agreement may then be undertaken.

In general, the agreement should cover the following details:

(1) The commencing date, the term it shall run, and provisions for periodic renewal or revision.

(2) Who the contracting parties are, and a brief description of the farm property involved.

(3) What capital will be used in the farm business, who will provide it, and how additions to it will be financed.

(4) What arrangements, if any, there will be for the son to increase his equity in the farm capital.

(5) How each party will contribute to the labour and management.

(6) How the records will be kept, and how money will be handled.

(7) What will be included as income and expenses, and how the income will be determined.

(8) How and when the income will be divided.

(9) What provision there will be for settlement of disputes.

(10) What living arrangements will be provided, and how joint household expenditures, if any, will be shared.

In the appendix of this bulletin a suggested form of agreement has been included, which may need to be adapted as required to suit individual cases. This type presumes that arrangements will be made for the son to buy out a half share of the working capital, or if there are two sons, each to secure a one-third share. It is felt that this procedure avoids some of the difficulties which might otherwise arise. However, it is not essential to start all agreements on this basis, particularly if the son is under twenty-one.

Some of the points to be kept in mind when filling in the details of the agreement will now be discussed.

Term of Agreement

It is difficult to arrive at an agreement which will extend over a period of several years, without sacrificing flexibility as conditions change. In some circumstances it may be desirable to enter into a father-son agreement for a term as long as five years, but usually a one year term, automatically renewable, is satisfactory. This permits the income-sharing proportions to be adjusted as the ratio of contributions change.

Extent of the Agreement

Although the fundamental basis for a family farm business agreement is mutual trust, it may be wise to insert provisions preventing one party from incurring excessive expenditures without the other's consent. A case in point might arise where either the father or the son had exceptionally weak "sales resistance" and was likely to prove an easy mark for every travelling salesman or agent. This might jeopardize the security of the whole farm business. To prevent this occurrence, agreement of both parties in the matter of capital expenditures, especially large ones, should be required, and a suitable proviso inserted in the operating agreement.

Sharing the Management

One of the difficulties in any democratic organization is the problem of how to get things done without at the same time riding roughshod over the minority. There is a fairly general tendency on family farms for the father to reserve the final authority in making management decisions. Not only does this frustrate the son who is of mature years and may have some sound and progressive ideas, but it does not afford him the training required in making decisions and profiting or suffering by them.

Ideally, therefore, the management of a family farm business should be a co-operative proposition. The father should encourage the son to discuss operating policies and business matters with him with a view to reaching a mutually agreeable solution. The son, on the other hand, should respect his father's maturity of judgment and experience, and realize that hesitancy to adopt every new suggestion may not necessarily reflect a non-progressive attitude. As the son grows older, and the father approaches the retirement age, there should be a steadily increasing transfer of responsibility to the younger man, once he has proven his mettle. There need not, in these circumstances, be any abrupt changeover from one "boss" to another.

Records

The necessity for an accurate accounting system for all farm partnerships cannot be stressed too highly. While one party usually must undertake to keep the records, both parties must co-operate to see that the necessary details and vouchers are turned in to the farm "office" weekly. The books should be open at all times to all those actively involved in the business, and should be carefully checked at the end of the year, preferably with the aid of an adding machine.

By the proper use of credit and banking facilities, the task of bookkeeping may be considerably simplified. The Ontario Farm Account Book, and other similarly prepared forms, are available to make the task still easier for the inexperienced.

Banking Facilities

The main point to be observed in connection with family farm banking arrangements, is that farm business must be kept entirely separate from personal and household expenditures. This means a bank account set up especially for the farm business and controlled jointly by father and son (with one or both empowered to sign cheques) and personal savings accounts controlled exclusively by each party.

If most farm income is received by cheque and deposited in the farm current account, and if all farm expenditures of any size, or personal withdrawals, are paid by cheque, the farm cheque book stubs, the cancelled cheques and the bank book will be useful accounting aids. The small remaining receipts or expenditures of cash may then be controlled by a voucher system.[6] This avoids the confusion which would be bound to occur if one party were to receive sums of money in payment for farm produce and then proceeded to buy groceries, clothing or furnishings for his particular household or settled small farm accounts, without bothering to keep a close record of all transactions.

While it is best to have a general reckoning at the end of each year, it is necessary to arrange for periodic advances to each party to meet living expenses. Probably the best plan is to agree on regular monthly withdrawals corresponding to wage allowances. Such withdrawals should not be so heavy, however, as to run the farm account short of operating cash, or cause a deficit at the end of the year.

Sharing the Income

The most logical basis for dividing the income of a family farm, as already indicated, involves consideration of what each party contributes to the operation of the business in the form of personal services and farm capital. Each member of the firm should expect to secure from the proceeds of the business a reasonable salary or wage for his work and managerial effort, as well as a reasonable rate of return on whatever capital he has invested. It will also be necessary to recover depreciation on such assets as machinery and buildings.

In determining the contributions of each party, however, common sense must dictate what values are attached to the personal contributions of each party, what valuations are applied to the farm and the working assets, and what rates of interest and depreciation are employed. It is best to adopt a conservative, long-term viewpoint.

Where the farm business is reasonably profitable, it may be wise for father and son to agree not to withdraw all earnings from the business each year. For example, a reserve equal to say ten per cent of the profits might be left in the farm account. This surplus could be used later on for capital improvements, or to meet possible contingencies which might arise. If the agreement were ever terminated, the surplus in the farm account would then be distributed, taking into account how much each party had contributed to it.

Provision for Capital Expenditures

In the normal course of events, every family farm business will periodically be faced with the necessity of undertaking certain capital expenditures. It may be a new machine, a new silo or other building, or some additional breeding stock. The question of how the funds to finance such expenditures will be provided, and the associated question of who will obtain title to the new assets, must be fully discussed and clearly understood.

It should be evident that new investments of capital in the farm business must either come from the personal savings accounts of father and/or son, or through credit arranged for by either party, possibly on the security of the farm business.

If the asset acquired is an item of working capital, that is to say, machinery or breeding stock, it would be advisable for father and son to share the original cost fifty-fifty and to hold title jointly. If funds are borrowed to finance the expenditure, father and son should sign a joint note, and share equally in repaying the principal with interest.

---

[6] This requires that all receipts or disbursements of cash be verified by invoices, bills, receipts or other documents.

If more land is acquired, it might well be that the son would wish to undertake financial responsibility, and to eventually acquire full title. He would, in this event, provide the down payment from his savings, and sign the mortgage. Interest on the mortgage would then be included as a farm operating expense, but payments on account of principal should come from the son's share of the farm profits. The latter would increase in proportion to his increasing equity.

New buildings or permanent improvements should normally be financed by whoever holds title to the land with which they are connected, unless it is definitely arranged how joint title to the improvements will be held. This is the same problem which arises in the case of tenant farmers who undertake permanent improvements to rented properties. The main difference with respect to family farm business is that normally the son expects to remain on the farm, and to enjoy the benefit of any improvements made, while the tenant may be forced to move on, and lose this advantage. No matter who holds title to the buildings, it would be well to provide for adequate fire insurance coverage, as loss of farm buildings by fire could cripple the operating agreement.

Division of Property at the End of Agreement

Proper inventory records should be maintained, indicating the ownership of the various assets, including new fixed and movable assets acquired from time to time, as well as natural increase in livestock. The yearly depreciation charges should also be recorded. This will simplify the problem of determining a fair basis for settlement of ownership claims whenever it becomes necessary or desirable to terminate the agreement. Only where the taking of inventory has been neglected, or where there has been failure to recognize the difference between capital or current expenditure, should there be any serious difficulty in establishing ownership claims to any of the farm property.

Where father and son each hold a half interest in the livestock herd, the problem may arise as to what is a fair value for breeding stock, particularly if a herd improvement policy has been carried on for a number of years. To settle the question fairly, it may become necessary to hold a complete dispersal sale at the time of the father's retirement, with the son purchasing the animals he wishes to retain. There is less necessity for a similar procedure in the case of machinery, since cost and replacement values for similar equipment are readily determined, and depreciation rates fairly well established. Special problems arise in connection with the transfer of title to real estate. This will be discussed in Part III of this bulletin.

Living Arrangements

When an agreement is arrived at before the son is married, he will normally continue to board with the parents. In this case it is reasonable to agree on an appropriate allowance for board and laundry to be paid to the mother, out of the son's income.

The marriage of the son, however, usually makes it necessary to provide for duplicate living quarters for the two families. This may involve the building of an additional house for either the son or the parents, or the re-modelling of the present farm home to provide two apartments. Many old Ontario homesteads have sufficient space for two families, although their design and construction may make the alterations rather costly. In the long run, however, comfortable living quarters for two families on a good-sized family farm represents a desirable investment.

Arbitration

Even in the best-regulated families, disputes may occasionally arise, which involve fundamental differences of opinion. In this event, recourse to arbitration may provide a much more desirable alternative than the entire breakdown of the agreement. This is the procedure which has often proven useful in the settlement of labour problems.

To work properly, the arbitration arrangements should provide for the appointment of arbiters whose integrity and judgment command respect. It must also be agreed in advance that the arbitration decision will be accepted as binding.

In most cases a thorough discussion of the point at issue, with advice, where desirable, from informed parties, will eliminate the necessity for arbitration, but it is helpful to know that it is provided for as a final resort.

PART III

Retirement Plans for Farmers and the Transfer of Farm Property

A family farm business agreement, properly designed and used, serves a very useful purpose in the important period between the time when the son has reached maturity, and when the father is ready to retire. But while it undoubtedly paves the way for the son to become soundly established in the farm business, it does not at the same time automatically provide for the transfer of the estate, or guarantee that the parents will be financially able to retire when they so desire.

When Should a Farmer Retire?

The proper age for retirement in any occupation has long been a contentious subject. One school of thought contends that too early a retirement is often later regretted. Another viewpoint is that one should retire while still able to enjoy well-earned leisure. There is probably some truth in both claims. There seems little doubt, in any event, that for every individual a time of life arrives when he should begin to take things a little easier, and eventually to surrender major burdens of responsibility. On the other hand, the financial ability to retire is always a major consideration, as well as the desirability of maintaining some contact with former interests.

The story is told of the farmer; who, having passed his three score years and ten, said one day to his son, himself a mature man of nearly fifty:

"Well, son, I guess its about time for me to be thinking about retiring."

"Oh, don't worry, Dad", was the reply, "just hang on a little longer, and we can both retire together."

But one of the virtues of farming is that theoretically at least, it provides an ideal opportunity for gradual retirement. Older farm folk who spend the sunset of life in familiar environment, working if and when they like, and maintaining an active interest in the state of the crops, the records of the livestock and so forth, do not have to adjust themselves suddenly to enforced retirement. The office worker, machinist, or carpenter, on the other hand, at retirement must make a clean break with the office or shop, and unless he has been wise enough to develop other interests, may find excessive leisure irksome. Of course the same possibility exists in farming, particularly when the farm couple retire to a town or city. There was a time when moving to an urban centre provided the only opportunity to enjoy modern conveniences, but with rural electrification being rapidly extended that time is passing. Today life in the country may be just as comfortable, and possibly a good deal more interesting, than life in the city.

The fact remains, however, that many farmers, for one reason or another, fail to enjoy a well-deserved retirement. Possibly through the lack of suitable farm business arrangements, the son has drifted away from the home farm, leaving no one to take over. The father struggles on for a few years alone, but continually reduces the scale of his operations, and allows the buildings and equipment to go down hill. He hesitates to sell the property, partly for sentimental reasons, but also because he is uncertain whether the total amount of cash realizable from a sale would be sufficient to provide an income for himself and his wife during the rest of their lifetime. So the farm gradually is converted from a productive unit to a place of retirement, with a declining market value.

In still other cases, the son may remain at home, but the father may insist on retaining management control until he has reached three score years and ten or more. The son, in such cases, finds that he must assume an increasing share of the work and worry, without a corresponding share in the management. It is also common, in such instances, for the title to the bulk of the farm property to remain with the father, through the lack of a definite business agreement permitting the son to gradually acquire an equity in the business.

In contrast to the two general types of undesirable situations just referred to, a much more satisfactory objective would be for the father to plan for a somewhat earlier retirement, and to begin planning at a much earlier date. This would involve a number of considerations such as:

(1) The development of a systematic plan of personal savings sufficiently early in life to provide for an adequate retirement income.

(2) The gradual shifting of the major responsibility for day to day management from father to son, and re-arrangement of the farm work plan to make the father's continual presence less essential.

(3) A decision by the father and mother as to where they wish to spend their retiring years, and the necessary arrangements to ensure suitable living accommodation.

(4) The working out of a satisfactory basis for the transfer of the farm property to the son.

(5) A plan for the disposition of the father's residual estate among the heirs.

Financial Problems of Retirement

A good deal is heard these days about "social security". Almost every human being apparently likes to contemplate financial independence, or at least financial security, later in life. But some people believe that a retirement income should result from their own planning and initiative, while others apparently are of the opinion that society should assume the major responsibility.

Farmers have the reputation of being the most independent people on earth, so they probably lean toward the former philosophy. Unfortunately the situation often arises whereby a farmer, at the end of an active farming career, has built up a successful farm business but finds it difficult to withdraw sufficient capital to guarantee his retirement, and at the same time keep the farm in the family, and operating at maximum efficiency.

The reason for this dilemma is that while the same avenues of saving and investment are open to farmers as to people in other walks of life, the most obvious place for a farmer to invest spare funds is in his own farm business. As long as he is a good farmer, and a sound business manager, this is all to the good. Generally speaking, the efficient farmer feels that he should be able to earn a higher return from every $100 invested in his farm business than the same amount deposited in the bank, or used to purchase government bonds or other securities. But it is a fact that investments in a farm business are less certain, and less quickly convertible into cash, than some other types of saving.

As long as the farm operator and his son can get their productive plant built up to peak efficiency while the father is still in the prime of life, there is of course every possibility that earlier investments will begin to pay dividends, and permit the latter to accumulate retirement savings. At the same time the son may be getting on his feet financially. But a number of possibilities may interfere with this desirable development. In the first place, there may be a temptation to continue to expand the farm business by buying more land, more machinery, more livestock and hiring more labour. This involves heavier financial commitments, requires more skilful management, and increases the risk in case of unfavourable seasons or downward price trends. If overexpansion occurs, the operator may find that he has not enough active lifetime left in which to complete his plans. Or he may have borrowed heavily just in advance of a lengthy period of depressed prices and reduced farm incomes. At the best, the result will be an extension of the period required to retire indebtedness.

Thus a farmer is continually faced with an investment problem — whether to invest all surplus funds in the farm business, or whether to utilize other forms of saving and investment such as life insurance or annuities. Probably no universal solution to the dilemma can be suggested, due to the wide variation in individual circumstances and requirements. However, there is no doubt that farmers generally should give a little more thought to what their financial position will be when it comes time for retirement.

The first aspect of the problem of course is to decide what amount of income will be needed annually for the father and mother to enjoy a comfortable retirement. The next task is to estimate the period of years during which the income will be needed. Unfortunately neither of these answers can be arrived at with certainty. Mortality tables are available to indicate what the average life expectancy at any given retirement age is, but the individual, or his wife, may life much longer, or shorter, than the average. Also living costs increase or decrease with changes in the general price level, and it is never possible to forecast when extraordinary expenditures, such as in the event of sickness, will become necessary. Where the parents retire on the farm, fluctuation in living costs may be a less important consideration, since rent will not be a factor, and farm perquisites will be available. It may not always be possible, however, for the parents to lay aside a capital sum, which at the going rate of interest for long-term safe investments, such as government bonds, will ensure a reasonable annual income. For example, if an income of $100 per month were desired, and

FIG. 5. Who would want to move to an urban community when a country home like this offers a wholesome and satisfying atmosphere for retirement.

the interest rate were 3 per cent, the return on a sum of $40,000 would be required to guarantee the income. On the other hand, a considerably smaller lump sum could be invested so as to provide a lifetime annuity of $100 per month.

Annuities

One way to provide for a guaranteed retirement income is by the purchase of an annuity, such as those obtainable from the Dominion Government.[1] Various plans can be followed in buying annuities, to suit individual circumstances. There are two main types known as:

(1) Deferred annuities.

(2) Immediate annuities.

Immediate annuities would be of most interest to older farm people on the point of retirement, who have savings available to invest, and wish to be assured of a life income starting immediately. Younger farmers, who are in a position to look farther ahead, might consider the deferred type of annuity, which can be purchased by smaller periodic instalments to mature at any desired retirement age, such as 60 or 65 years.

In addition to these two main types of purchase plans, various other alternatives are available. Under one arrangement, the annuity simply provides a guaranteed monthly income for the remaining life of the person, whether it be one year, or forty. Under another which is slightly more costly, the income is guaranteed to the person, or in case of death, to his heirs, for a definite minimum period of 5, 10, 15 and 20 years. Still a third variation is known as the "last survivor annuity" whereby husband and wife purchase an annuity jointly, with the full income paid while both are still alive, and then continues at a prearranged rate, sometimes one-third less, to the last survivor as long as he or she lives. In the case of all annuities, if death occurs before the annuity is due to mature, all payments made are returned with compound interest.

---

[1] Detailed information regarding government annuities is obtainable at post offices, or by writing to the Director of Annuities, Department of Labour, Ottawa.

Farm people should therefore study carefully the possible application of annuities to their retirement problems. It would, for example, be possible to start payments on a deferred annuity for the parents during the productive years when both father and son are active in the family farm business. In exchange for a suitable paid-up annuity, the parents might then agree to transfer the title of the farm to the son. A joint survivorship annuity, or separate annuities for each parent, would ensure the continuation of income to the last surviving parent.

A very interesting application of the annuity principle has been suggested recently by R. R. Botts.[2] He attempts to find an answer to the perplexing problem of how the parents may best turn over the farm to the son, and at the same time ensure themselves a retirement income, make provision for other heirs, and not cripple the son financially.

In brief, his proposal is that when it comes time for the parents to retire, assuming they still hold the deed to the farm property, that the following steps be taken:

(1) The farm be fairly appraised to determine its "normal agricultural value". (Disregard temporary high prices for farm products and for land). The parents agree to sell the farm to the son for this sum.

(2) Decide what proportion of the appraised value the parents require to provide a retirement income. This would be determined by the cost of an immediate joint-survivorship annuity. The son enters into a definite contract to pay the parents a monthly income for life in exchange for title to the farm.

(3) The difference between the appraised value of the farm, and the sum required to purchase such a life annuity, becomes part of the parent's estate, and is divided between the heirs. The son pays the other heirs their shares in instalments.

As an illustration of how this procedure would work out, we might take an example. Assume a farm property, appraised at $12,000 is owned by the father, plus his share of the stock and equipment at $3,000, making a total valuation of $15,000. We will assume further that the father is 65, the mother 63, and that there are two other children, a son and a daughter, besides the son at home, The parents calculate that an income in cash of $70 per month (plus the usual farm perquisites) will be sufficient while both are alive, with a reduction of one-third on the death of one parent.

On the basis of current[3] rates for Dominion Government annuities, we find that at the parents' respective ages of 65 and 63 a lump sum of $1000 will provide for an immediate last-survivor annuity of $71.06 annually, with a one-third reduction on the death of either party. Thus to provide a *monthly* income of $70, would necessitate a lump sum payment of approximately $12,000. Incidentally had the father been only 50, the corresponding sum would have been nearly $16,400, and had he been 70, slightly over $10,000. (See appendix, Table 1).

---

[2] See "Use of the Annuity Principle in Tranferring the Farm from Father to Son" by R. R. Botts, *Journal of Farm Economics*, May, 1947.

[3] 1949.

However, at age 65, an investment of about $12,000, out of the farm value of $15,000, would provide a life annuity of $70 per month for the parents. The residual estate of $3,000 we shall assume, will be divided equally among the three children, leaving the son on the farm $1000 to pay to each of his brother and sister. This could be amortized, say on a 10 year basis. Assuming a 3 per cent interest rate, similar to the annuity, ten annual instalments of $117,20 to each heir would discharge the obligation.

Thus in exchange for complete title to the farm property, valued at $15,000, the son would contract to pay the parents $70 per month while both live, and about $47 per month to the last survivor, plus $117.20 per annum to each of the other two children for ten years. In other words, his immediate total annual obligation would be about $1075. The total sum he would eventually have to pay out would of course depend on the longevity of his parents.

While Mr. Bott's suggestions possess a good deal of merit, and are worthy of particular study in cases where no advance planning has taken place, it must be noted that his plan does not afford the maximum financial protection for the parents should the farm income drop for any reason, or should anything else seriously interfere with the son fulfilling his annual commitments. While any such occurrence would constitute a default of the terms of the contract whereby the son secured possession of the farm property, it would nevertheless be a constant source of financial insecurity for the parents.

To provide them with a more secure retirement income, and at the same time not place the son under too great a financial handicap, an alternative plan might be followed. Its exact nature will depend on the period of time available in which to make provision for the parents' retirement, and the transfer of the property to the son.

To illustrate one possible type of situation, let us assume that the father is 50 and the son 25. They have already agreed upon a suitable plan for the joint operation of the farm business and the sharing of the farm income. But being far-sighted individuals, both father and son wish to look forward a bit farther to the time when it will be desirable for the former to retire from active farming, and the latter to take over the business entirely. We shall further assume that a conservative appraisal of the long-term agricultural value of the farm is $12,000. The father plans to retire in fifteen years when he is 65, and figures that a retirement income of $1200 annually should be sufficient for him and his wife, since they have provided for suitable living accommodation on the farm.

Enquiry reveals that a deferred government life annuity of $100 per month commencing at age 65, and guaranteed for 10 years, may be purchased for the father, at his present age of 50 either by monthly instalments of $67.56 or by annual payments of $799.56.[4] If the annual payment plan were adopted, the total paid in over the next 15 years would be $11,993.40, which in this case, coincides almost exactly with the value arrived at for the farm.

Thus, by starting an annuity contract when the father is at age 50, with annual payments undertaken by the son, at age 65 the father and mother could retire with a guaranteed income of $100 per month while the son would then obtain title to the farm.

---

[4] At present rates, according to data provided by the Annuities Branch, Department of Labour, Ottawa.

Of course, not all situations would work out as smoothly as the preceding example. In some cases the appraised value of the farm may be considerably less than the total cost of a deferred annuity sufficient to provide a comfortable retirement income. In this case the parents must depend on savings of their own, to supplement whatever amount of annuity the price of the farm will purchase. It is also possible that the son might encounter a few adverse years which would prevent him from making his current annuity deposits in full. Since the annuity contract is flexible, and permits back payments to be made up later, there is no danger of losing what has been saved. Starting the annuity premiums for the father at an earlier age, or advancing the father's retirement age to 70 would of course spread the financial contract of the son over a longer period, and reduce the annual commitment necessary. It might also be desirable to consider the purchase of separate annuities for the father and mother, a joint-survivor annuity, or one guaranteed for 20 years, to provide adequate security for the mother.

As long as the farm is not appraised at too high a figure in relation to its long-term productive capacity, and if the son is not required to fulful his contract in too short a period of years, the foregoing type of transfer arrangement seems eminently fair to the son. Instead of assuming an interest-bearing obligation, such as would be the case if he were purchasing the farm under a mortgage contract, the purchase of an annuity for the father, actually guarantees the son Compound interest on his savings. Thus the differences between the total cost to him under such a program, as compared to an amortized mortgage repayment plan, would be considerable. In fact, retirement of $12,000 mortgage principal with interest at 5% (See Appendix Table 3) would require 15 amortized payments of $1156.08, or a total of $17,341.20. This compares with the total cost of $11,993.40 under the annuity plan, so that the latter represents a substantial saving.

In the event that the son found himself unable to meet his commitments under the original annuity contract in full by its maturity date, he might then be required to assume a mortgage on the farm to the extent of the unpaid balance. The parents would then receive an annuity for whatever sum was paid-up, while the mortgage loan could be applied to the purchase of a further immediate annuity. In this case the son's mortgage indebtedness would be much less than if no deferred annuity contract has been undertaken, and his period of payment for the property would be lengthened.

Situations constantly arise, however, where there is almost a complete lack of advance planning up to the time when the father and mother feel they should retire. The farm may be free of encumbrance, but neither the parents nor the son have very substantial cash savings. In these circumstances, Mr. Bott's plan as previously described may be followed. But to provide a greater measure of independence and security for the parents it may be desirable for them to sell the farm to the son, on the condition that he mortgage it, and purchase an immediate annuity for them in a lump sum equal to the mortgage. The balance of the farm price might then be paid off in monthly instalments, to supplement the annuity.

In the previous example, with the farm valued at $12,000, let us assume that a mortgage is obtainable for $8000 at 5%. At the father's attained age of 65, a lump sum premium of $8000 would purchase an immediate annuity, guaranteed for ten years, of $627.92 per year.[5] This would be supplemented by the son's repayment of the remaining $4000 in instalments, and any savings the parents had. Under this arrangement, the cost of the farm to the son would be higher, since he would have to pay off the mortgage with interest, in addition to paying the balance of the farm value to the father. Moreover, the annuity for the parents would be more costly, since the rates for immediate annuities are higher than those for deferred plans. However, the parents would enjoy somewhat greater security than under the Botts' plan.

---

[5] At current rates (1951).

While the circumstances surrounding the transfer of farm property from one generation to the next may vary considerably from one situation to another, it appears that the annuity plan is adaptable to the majority of cases. The exchange of a paid-up annuity contract for title to the farm property, seems to provide one answer to the problem of how to keep the farm in the family and still permit both father and mother to enjoy a financially secure old age. To be most effective such a program should be started at least ten years in advance of the father's retirement, in fact the sooner the better.

Life Insurance

Various types of life insurance policies can be utilized to assist farmers and their sons in providing security for their respective families during the transfer of the business from one generation to the next. A working knowledge of the main types of life insurance is a valuable asset for any farm operator, so that he may more intelligently discuss his requirements with an underwriter whose competence and integrity is respected.

The question as to the type and amount of life insurance an individual farmer should carry requires a variety of answers, depending on the circumstances. Where protection is a prime consideration, such as for the young farmer with a wife and growing family and considerable financial obligations, "term" or "ordinary life" types of policies are generally the first thought. As the family grows up and indebtedness is gradually retired, the need for protection diminishes. At this stage the investment aspect of "endowment" or "pension plan" policies may be worthy of greater consideration.

Insurance programs may be worked out to apply specifically to people engaged in various types of businesses, whether sole proprietorships, partnerships or limited companies. One of the objectives of "business insurance" may be to protect the firm itself against the untimely decease of an important member. Another consideration, in a partnership for example, is to make it possible, by means of insurance, for the surviving partner to buy out at once the deceased partner's interest in the business without undue financial hardship. It seems quite possible to apply these same general principles to a family farm business, to avoid some of the financial complications which usually arise if the father (or the son) should die before the complete transfer of the business is effected.

To illustrate the possible application of life insurance to the solution of family farm business problems which may arise in the absence of sufficient advance planning, the following case may be cited:

Harry B. took over the management of the family farm shortly after he was married at 28 years of age. His parents continued to live in part of the farm home, and the father, then about 60, assisted with the farm work. Previous to this time Harry had received no definite wages from his father, merely a small monthly allowance for personal expenses.

The terms under which Harry agreed to assume managerial responsibility were that the father would receive a cash rental of $600 per year, would continue to hold title to the farm property, and would retain ownership of stock and equipment to an amount equivalent to the inventory at the start of the agreement.

Things proceeded on this basis for 5 or 6 years, during which time Harry successfully operated the farm, buying more equipment and improving the herd of livestock. At the end of that time Harry asked his father to consider a more permanent basis of settlement. He had several reasons for this request. The arrival of two children had increased his responsibilities and the necessity for providing his wife with greater security. Continued slight friction between his wife and his parents made it desirable to consider independent financial arrangements in case anything should suddenly happen to him. The necessity for making substantial capital improvements to the farm and buildings at an early date brought up the question of the basis on which Harry might expect to attain eventual ownership of the property, since there were other heirs, a brother and sister as well as the Mother also to be considered.

At first Harry's father persistently refused to entertain the possibility of a buy and sell agreement for the farm, suggesting that he would make suitable disposition of the estate by will. However, he would not reveal exactly what he had in mind.

Things dragged on unsatisfactorily, until Harry had reached the stage where he was considering leaving the home farm entirely. At this point his father consented to a conference in his lawyer's office, and certain proposals and counter-proposals were set forth. The father finally agreed to sell the farm property for $13,000, which Harry considered a rather stiff price, and further intimated that Harry's only share in the estate later would consist of the father's equity in the stock and equipment.

At first it appeared as if a deadlock has been reached, and that Harry would be forced to leave the farm after all. Finally, however, a compromise was effected whereby the father reduced his terms somewhat to the point where Harry thought he could reasonably expect to finance his obligations, and consented to carry on under a purchase agreement. The parents meanwhile bought a small home nearby in which to spend their retiring years.

The foregoing actual case history illustrates the personal and financial problems which may develop on the family farm if the son continues to work on at home without a definite understanding with his father. Like the story of the Prodigal Son, it may often appear that the boy who stays on the job gets rather unjust treatment. Of course it is also necessary to consider the position of the parents, who may have worked hard to rear their family and to clear off their financial obligations, and have a right to expect reasonable financial security in retirement,

In the case cited, however, lack of a systematic financial plan, and a hesitancy to discuss family business problems freely and in good time, complicated the transfer of ownership and management of the farm business and the plans for the parents' retirement. As a result neither the son's wife nor the parents felt that they had adequate financial security as things stood.

The fundamental requirement in such instances is to work out some plan to ensure that the family farm income will be maintained at a satisfactory level during the first few years after the son takes over. The assurance of his continued earning power during this period is essential in two respects:

(1) To provide continued security for his wife and family.

(2) To complete an adequate financial settlement with the parents as required to ensure their retirement security.

A life insurance policy for the son could provide his wife and family with some protection in case his earning power were suddenly terminated by death

FIG. 6. A two year course in agriculture plus a satisfactory working arrangement with the father helped the son on this family farm to assume the management of an above average enterprise.

before he had retired his obligation to the parents resulting from the transfer of the farm property. Assuming that the son had agreed to purchase the farm under an amortized plan, his insurance policy could be assigned to the father as collateral, with the provision that the latter's claim against it would disappear as the obligation was cleared off. In the event of the son's death, the proceeds of the policy would be applied to the retirement of any remaining mortgage indebtedness, leaving the widow in full possession of the farm, subject to the provisions of her husband's last will and testament. At the same time the parents' interests would be fully protected.

Since the son would be desirous of clearing off his obligations to the father as quickly as possible, it would appear that a low-premium type of policy, affording a high degree of protection, in relation to the annual outlay, would be advisable for the purposes just stated. This would suggest consideration of term insurance, or possibly ordinary life, carrying the usual option to convert to a higher-premium plan at a later date, if desired. There is also available a special type of low-cost plan commonly known as "mortgage insurance", which provides for a gradually reducing coverage as the mortgage principal is paid off. At all times the face value of the policy is sufficient to retire the unpaid balance, should the mortgagor die. This contract would, of course, terminate when the mortgage was paid off.

Much better arrangements could have been provided in the case cited, had both the father and son exercised more foresight in anticipating the financial problems which would eventually arise with respect to the transfer of the property. As far as the father is concerned, one plan he could have followed would have been to purchase insurance to the amount of about $10,000 on his own life at age 35 or 40, possibly of a convertible low-cost type. He would then have paid the annual premiums on this policy himself up to the time when the son was in a position to take over the business. At this stage the policy could be assigned to the son, who would then control it and take over payment of future premiums. In the event of the father's death before the son had completed payment for the farm, the proceeds of the policy would be applied in retiring the remaining indebtedness. This would provide the son with clear title to the farm and at the same time would protect the mother and other surviving heirs, under the terms of the father's will.

Since the son may not have received cash wages at the full prevailing rate during the first few years, such as was true in Harry's case, part of the father's premium payments in the policy which he plans to later assign to the son, actually constitute a consideration in lieu of wages.

A further alternative which is also worthy of note would be for the son to look ahead to the time when his father plans to retire, and may wish to dispose of his equity in the farm. Let us say, for example, that when Harry was 20 and his father 45, they both had agreed that at the end of a further 15 years the father would be ready to sell out to the son. A businesslike procedure would then have been for them to have a "buy and sell" agreement drawn up, indicating the father's willingness to sell, and the son's willingness to buy the property at a stated figure. To ensure that he would be in a financial position to complete the deal at the appointed time, the son would then have to consider a systematic plan of savings. This could, for example, take the form of a 15-year endowment policy on the father's life, which at age 45 would require an annual premium outlay equal to about 6½ per cent of the face value of the policy. Thus when the father reached 60 the matured contract would provide the son with sufficient funds to meet all or part of the purchase price, as stipulated under the buy and sell agreement. In the event that the father had died unexpectedly before reaching 60, however, the full amount of the policy would have become immediately available, enabling the son to exercise his option under the agreement, and at the same time protecting the position of the mother and other heirs. In this way, an endowment policy on the life of the father, paid for and owned by the son, coupled with adequate low-cost protection on the son's own life. and with a buy and sell agreement for the farm in writing would afford a substantial degree of security to the whole farm family. It is true that farm earnings would have to be kept at a sufficiently high level to underwrite the program, but this is necessary and desirable in any event.

The foregoing may serve to suggest some of the possible ways in which the protection and investment features of life insurance may facilitate the carrying out of family farm business arrangements. Every individual case requires special study and planning.

Inheritance Laws and Taxes

Every individual who owns property has the right, in normal circumstances, to indicate by means of a will, what his intention is with respect to how the property shall be distributed or administered after his death. Statutory provisions with respect to wills, as well as the laws of property and related matters are contained in Section VIII of the Revised Statutes of Ontario (1937).

In cases where a legal will is not made before death, the person is said to have died "intestate" in which case the "Devolution of Estates Act" (Section VIII, Chapter 163) sets forth the manner in which the estate shall be distributed. The provisions of this legislation are too complex to be discussed in detail here.

The extent to which ownership of property has already been transferred before death, the nature and extent of wealth possessed and the number of heirs involved, all affect the relative importance of a will. However, as a general rule, a farmer, or any other person, should make a will early in life as he begins to accumulate an estate, and amend it from time to time as circumstances warrant. Legal assistance in drawing up the will itself is usually desirable, although the solicitor should not be expected to decide what is ethically the right course of action.

The testator is required to name in the will an executor, or executors, whose responsibility it becomes to see that the wishes of the deceased are carried out. The executor, upon the death of the testator, applies to the Surrogate Court for probate of the will. If the court is satisfied with the documentary evidence, letters of probate are issued, which empower the executor to transfer the property according to the terms of the will.

Among the duties of the executor are the paying of all lawful debts and claims against the estate. This will include unpaid income tax liabilities, as well as succession duties if the estate is of considerable size. Where the farm operator has filed income tax returns regularly, whether or not his income has been taxable, the problems of winding up the estate are much simplified. Also it avoids the necessity, if it is found that back taxes are due, of raising the necessary cash to meet accumulated tax liabilities and penalities. Frequently one hears of farm families being placed in serious financial difficulties through the neglect of the father to keep in good standing with the income tax department, and a lack of forethought as to how his estate should be transferred.

The question of succession duties is mainly one which is of concern to larger family estates. Under present regulations, Dominion and Provincial succession duties usually apply in cases where the estate exceeds $50,000. However, these regulations are subject to change by Act of Parliament, and it is always wise to ascertain from reliable sources what the most recent regulations are. Through the operation of a long-term family farm business agreement, with additional provision for the gradual acquisition of farm property by the son, the average family farm need have little to fear from succession duties and inheritance taxes, providing the letter and spirit of the law is observed, and that things are not left until the eleventh hour. As previously indicated, the operators of very large farm businesses might well consider incorporation, as a means of ensuring continuity of operation from one generation to the next.

Summary

Plans for the parents' retirement and the transfer of the family farm property should be developed along with, or at least shortly after the drawing up of the father-son partnership agreement. In each situation there probably will be one plan which is on the whole fairest and best. But any one of several plans will likely be reasonably satisfactory, and better by far than no plan at all.

The important thing is to get the plans under discussion and acted upon, before it is too late. If things drag on with no definite arrangement until it comes time for the father and mother to retire, the problem may become altogether too involved. A systematic program, financed out of income over a period of years is much more satisfactory than an emergency settlement, which often leaves the parents without sufficient security, the son at home heavily-obligated and other heirs unfairly treated.

The key factor in the situation is of course a good farm, well-farmed and managed, and yielding a satisfactory income. Unless sufficient income has been produced, and is still being produced, any financial settlement satisfactory to all parties will be difficult. At the same time, if the farm income has been high enough but has been unwisely spent or invested over the years, the problem will still remain.

The various types of arrangements which have been suggested in this bulletin will no doubt be criticized by some readers on the grounds that they are either too complicated, or are too difficult to finance. These may well be valid objections, but the fact remains that no easy solution to complex family farm problems seems possible. Moreover any practical working arrangement which can be suggested requires some degree of financial effort and sacrifice by all concerned before it can be carried to a successful conclusion. Each farm family group in Ontario must be prepared to face its own business problems squarely and to do some straight thinking and sound planning with the necessary professional advice to ensure that the chain of family succession remains unbroken.

APPENDIX A

Table 1 — Cost of Immediate Last Survivor Annuity, Reducing by One-third on Death of Either Party. *

Age of Male	Age of Female	Yearly Annuity per $1000 Invested
50	48	$51.36
51	49	52.21
52	50	53.11
53	51	54.05
54	52	55.09
55	53	56.15
56	54	57.27
57	55	58.49
58	56	59.76
59	57	61.08
60	58	62.50
61	59	64.01
62	60	65.60
63	61	67.31
64	62	69.14
65	63	71.06
66	64	73.14
67	65	75.36
68	66	77.70
69	67	80.26
70	68	82.99

* Based on current rate of 3 per cent payable on Canadian Government Annuities. Cost for other ages available on application to Director of Annuities, Department of Labour, Ottawa.

Table 2a — Cost of Deferred Male Life Annuity Guaranteed for 10 years (Monthly Premium per $100 of Annuity)

	Annuity Matures at				
Age last birthday	50 years	55 years	60 years	65 years	70 years
25	3.97	2.76	1.95	1.39	1.00
30	5.35	3.60	2.47	1.73	1.23
35	7.79	4.89	3.23	2.20	1.54
40	12.64	7.06	4.38	2.87	1.95
45	27.29	11.45	6.33	3.90	2.55

Example: The monthly premium for an annuity of $100 per month maturing at age 65, with payments starting at age 35 would be $26.40 (2.20 × 12).

Table 2b – Cost of Deferred Male Life Annuity, Guaranteed for 10 years (Single lump sum premium for $100 Annuity)

	Annuity Matures at				
Age last birthday	50 years	55 years	60 years	65 years	70 years
25	843.88	659.71	509.98	391.29	299.53
30	978.29	764.79	591.20	453.61	347.24
35	1,134.11	886.60	685.36	525.86	402.54
40	1,314.74	1,027.81	794.52	609.62	466.66
45	1,524.14	1,191.52	921.07	*706.71*	540.98

Example: At age 45, to purchase an annuity paying $100 monthly at age 65 would require a lump sum payment of $8,480.52 (706.71 × 12).

Table 3 – Percentage of loan required to be paid periodically to amortize a given loan.

	Interest Rate per Annum			
Term of Years	3%	4%	5%	6%
1	103.000	104.000	105.000	106.000
2	52.261	53.020	53.780	54.544
3	35.353	36.035	36.721	37.411
4	26.903	27.549	28.201	28.859
5	21.835	22.463	23.097	23.740
10	11.723	12.329	12.950	13.587
15	8.377	8.994	*9.634*	10.296
20	6.722	7.358	8.024	8.718
25	5.743	6.401	7.095	7.823

Example: To find the annual instalment necessary to repay $1000 in 15 years at 5% in equal amounts:

$$\$1000.00 \times \frac{9.634}{100} = \$96.34$$

Total cost of loan = $96.34 × 15 = $1445.10

Total cost if not amortized = 15 years interest at
$50 + $1000 = $1750.00.

Table 4 – Percentage of sinking fund required to be saved annually to accumulate such fund in a given number of years at various interest rates.

	Rate of Interest per Annum			
Term of Years	1½%	2½%	3%	3½%
5	19.409	19.025	18.835	18.648
10	9.343	8.926	8.723	8.524
15	5.994	5.577	5.377	5.183
20	4.325	3.915	3.722	3.536
25	3.326	2.928	*2.743*	2.567
30	2.664	2.278	2.102	1.937

Example: To accumulate a fund of $15,000 at age 65, starting at age 40 (25 years) would require an annual sum to be set aside of $411.45 $\left(\frac{15000 \times 2.743}{100}\right)$ assuming an interest rate of 3%, compounded.

Table 5 — Amount of $1 (principal plus interest) invested at compound interest over varying periods.

	Rate of Interest per Annum			
Term of Years	1½%	3%	4½%	6%
5	1.077	1.159	1.246	1.338
10	1.161	1.344	1.553	1.791
15	1.250	1.558	1.935	2.397
20	1.347	1.806	2.412	3.207
25	1.451	2.094	3.005	4.292
30	1.563	2.427	3.745	5.744

Example: The investment of $1000 at age 40 at 3% compound interest would amount to $2,094 at age 65, or if invested at 6% to $4,292.

APPENDIX B

FAMILY FARM BUSINESS AGREEMENT

This agreement, entered into this .... day of .... 19 .
between .... and ....
Father Son
concerns the operation of a farm business carried on in the County of
in the Province of .... on the following premises:

....

....

(Give Concession, Lot and Township or Municipality)

A. *Term of Agreement*

This agreement is for a term of ... year(s), from the ... day of .... 19 ..... to the .... day of .... 19 ... . It shall be renewable from year to year thereafter unless either party gives written notice of a desire to terminate or change the agreement at least .... months before the anniversary date.

B. *Extent of the Agreement*

This agreement is not in itself to be construed as creating an unlimited partnership. Neither party shall be entitled to incur debts or obligations in the farm name, or to dispose of any farm property, where the total sum involved is in excess of $.............. , without the other's express knowledge and consent, except as may be herein provided.

Otherwise the terms of the agreement shall be binding upon the heirs, executors, administrators and assigns of each party.

C. *Sharing of Management*

The contracting parties hereby agree to co-operate in all decisions relative to the organization and management of the farm business. Decisions respecting the annual crop and livestock program, the time and method of marketing farm products, and like matters shall be subject to mutual agreement.

D. *Keeping of Records*

To facilitate the operation of this agreement, a farm accounting system will be maintained by .... The information to be recorded in the Ontario Farm Account Book or other suitable form shall include:

(1) A daily record of farm cash receipts and expenditures.

(2) A yearly inventory of farm property, both fixed and movable, as of January 1st, indicating the ownership thereof.

(3) Such annual records of crop and livestock production as are deemed necessary.

(4) A record of perquisites supplied to each household by the farm.

(5) A record of monthly cash advances made to each party from the farm account.

The farm records shall be freely available to each party for inspection at any time. Supporting vouchers and documents shall be kept on file for at least one year.

E. *Arrangements for Banking Facilities*

To provide a systematic basis for receiving income and paying expenses, a joint farm bank account shall be maintained at ....
(Indicate Bank)
All farm expenditures in excess of $................. must be paid by cheque from this account, cheques to be signed by .... Small expenditures under $................. may be paid in cash by either party, with monthly reimbursement by cheque on presentation of vouchers covering the transactions.

Farm income, in cheques or cash, shall be deposited in the farm account as soon as possible after it is received.

Monthly cash advances for personal and household requirements may be drawn by each party from the farm account as follows:

Father: $.................. per month
Son: $.................. per month
Extra cash advances may be drawn by mutual consent.

F. *Contributions*

(1) *Labour*

The value of each party's personal services, to be used as a basis of arriving at total contributions to the farm business, shall be determined at the following rates:

Father: .... months at $ .... per month

Son: .... months at $ .... per month

(2) *Fixed Capital* (Farm and Buildings)

A fair, appraisal value for the real farm property owned and operated in connection with the farm business as of .... 19........, is as follows:

		Owned by	
	Total	Father	Son
Land	$................	$................	$................
Buildings	....	....	....
(Less) Mortgage, if any	....	....	....
Owner's equity	....	....	....
Interest on equity at ....%	....	....	....

(3) *Movable Capital* (Livestock, machinery, feeds and supplies)

The inventory values of chattels used in the farm business as of .... 19........, are:

		Owned by	
	Total	Father	Son
Livestock	$................	$................	$................
Machinery and Equipment	....	....	....
Feeds and Supplies	....	....	....
Grand Total	....	....	....
Interest thereon at ....%	....	....	....

To enable the son to acquire a larger equity in the farm business. particularly in the movable capital, the following arrangements are agreed upon:

....

....

....

....

Summary of Contributions

	Father	Son	Total
Personal Services	$................	$................	$................
Fixed Capital (interest)	....	....	....
Movable Capital (interest)	....	....	....
Total	$................	....	....
Per cent of Total	....	....	....

G. *Division of Income*

The net income from the farm business shall be shared annually in the same proportion as the contributions thereto, as set forth in Section F. preceding.

In calculating the amount of the net income, the total cash farm receipts, as shown in the farm account book, shall first be ascertained. This total shall include income from all livestock and farm produce sold, custom work and labour for hire, rebates, patronage dividends. prizes. and all other revenue in connection with the farm business.

The total farm operating expenses shall also be ascertained from the records, including hired labour, feed, seed, fertilizer, fuel and grease, repairs to machinery, buildings and fences, taxes, veterinary expenses, insurance, bank and mortgage interest, farm share of electric power, telephone and automobile, depreciation on machinery and farm buildings owned jointly and all other expenditures incurred in connection with the year's business. New capital expenditures for land, buildings and improvements, for machinery or for breeding stock should not be included in this total.

The net farm income to be divided will be ascertained by deducting the farm operating expenses from the cash receipts. Each party shall then be entitled to the proportion of the net income to which his contributions entitle him, less the total of any personal withdrawals from the farm accounts made during the year, as provided for in Section E.

The balance in the farm account shall constitute a reserve for depreciation and shall also be available for financing current operations or capital expenditures, subject to mutual agreement.

H. *Provision for Capital Expenditures*

From time to time additional investments in the farm business may be required for the purchase of land, machinery or breeding stock, or the addition of permanent improvements to real estate. Ordinarily these capital expenditures must either be financed out of savings, or through loans to be repaid from future income. The depreciation reserve remaining in the farm bank account may also be utilized after sufficient funds have accumulated.

It is understood that as each new capital asset is acquired, whose value exceeds $.................., the method of financing it will be agreed upon, and the equity of each party in it shall be recorded in the annual inventory.

I. *Division of Property at Conclusion of Agreement*

If for any reason this agreement is terminated, any farm property which has been held or acquired jointly may either be offered for public sale and the proceeds shared in proportion to the respective ownership claims, or if one party is continuing in the business, he may first be given the opportunity to acquire ownership of such property by a mutually satisfactory cash settlement.

The following arrangements are agreed upon with respect to the natural increase in livestock: ....

....

....

....

....

....

J. *Provision for Living Arrangements and Farm Perquisites*

Living arrangements for the farm families shall be as follows: ....

....

....

....

....

....

(Indicate living quarters, value of board and laundry if furnished, method of apportioning any joint household expenses such as light, heat, telephone, etc.)

Each family shall be entitled to the following farm perquisites: ....

....

(Indicate dairy products, eggs, meat, fruits and vegetables, fuel, etc. to be supplied from farm.)

K. *Provision for Arbitration*

Any disagreement which may arise between the contracting parties, respecting the joint operation and management of the farm business as provided for by this agreement, shall, when a mutually satisfactory settlement cannot otherwise be reached, be submitted to arbitration. The arbitration authority may either be a single person mutually satisfactory to both parties, or a board of three, one member to be named by each party and a third selected by the two so chosen.

The recommendation of the arbiter or arbitration board shall be accepted as final, except in a matter of law.

L. *Other Provisions*

....

....

....

....

....

....

Witness our hands this .... day of .... 19 .... .

Signed:

....

....

(Witness)

BIBLIOGRAPHY

●

A Father and Son Business Arrangement for Prairie Farmers
Mimeographed Report, Economics Division, Dominion Department of Agriculture, Ottawa.

Father and Son Farm Partnerships, *by E. B. Hill*
Special Bulletin 330 (April, 1944) Section of Farm Management, Michigan State College, East Lansing, Michigan.

Father-Son Farm Business Agreements
Circular 587, University of Illinois, College of Agriculture, Urbana, Illinois.

Father and Son Arrangements
Bulletin 219, Ohio State University, Columbus, Ohio.

Farm Business Arrangements for Father and Son, *by J. B. McNulty*
Extension Bulletin 248, University of Minnesota, St. Paul, Minn.

Father and Son Arrangements
Bulletin A.E. 533, Department of Agricultural Economics, New York State College of Agriculture, Ithaca, N. Y.

Keeping the Farm in the Family
Bulletin 157, University of Wisconsin, Madison, Wisc.

Father and Son Farm Business Agreements
Bulletin 492, Pennsylvania State College, State College, Pa.

Selecting Your Farm Inheritance Plan
Leaflet, Michigan State College, East Lansing, Michigan.

Managing Farm Finances
Miscellaneous Publication No. 652, Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C.

Annuity Tables
Published by Annuities Branch, Dominion Department of Labour, Ottawa.

PRUNING ORNAMENTAL TREES, SHRUBS AND VINES

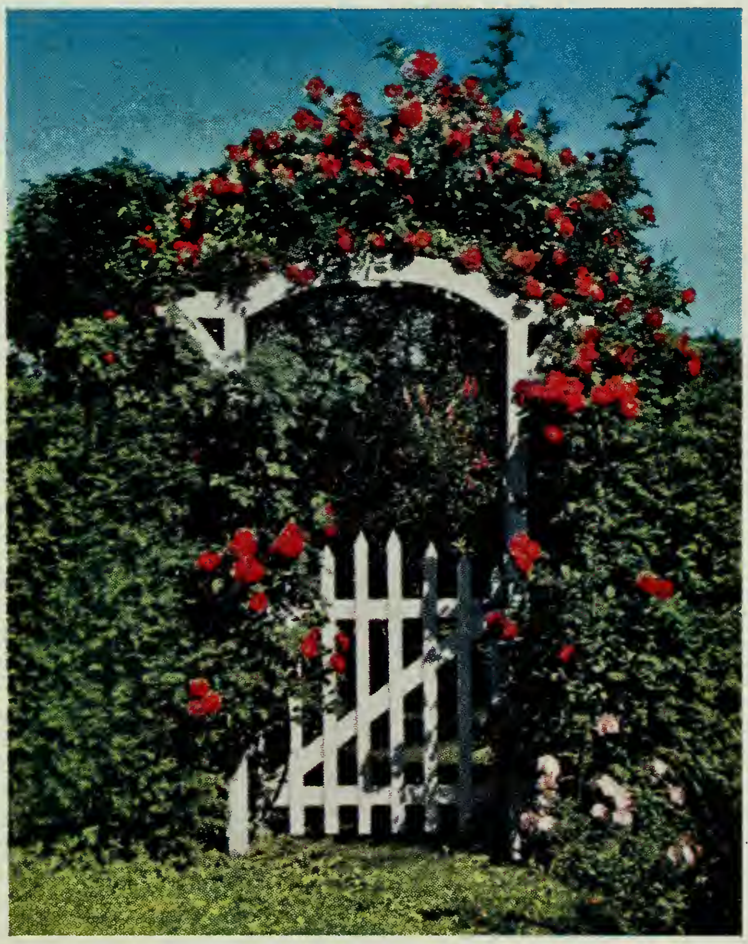
●

By J. A. WEALL and J. S. SHOEMAKER

DEPARTMENT OF HORTICULTURE

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO



ONTARIO DEPARTMENT of AGRICULTURE

STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 483 JANUARY, 1952

PRUNING ORNAMENTALS

by

J. A. Weall and J. S. Shoemaker

INTRODUCTION

The pruning of ornamental trees, shrubs, and vines has not previously been described in an Ontario publication as has been done with orchard trees and small-fruit plants. There is, therefore, a definite need for an informative illustrated guide such as is presented in this bulletin. The need is a very widespread one as planting of the home surroundings is carried on by a very large number of persons who are not well informed on the subject of pruning.

Pruning is a very old subject and therefore it might be thought that the reasons for doing it, and the best procedures to follow, would be well understood and practised. Unfortunately, however, pruning is too often done in ways that are neither wise nor skilful. Improper pruning may result in more harm than good. In fact, it may be better in many cases not to prune than to prune without a reasonably clear idea of the results that will occur. When pruning is practised it should be done intelligently.

BASIC REASONS FOR PRUNING

An understanding of the basic reasons for pruning is very helpful as a guide to the best procedure to follow. No one can prune properly without knowing the reasons for pruning. The basic reasons for pruning ornamental trees and shrubs are given in this preliminary discussion. These basic considerations are followed by a more detailed discussion of pruning operations under appropriate headings.

Pruning to Encourage Successful Planting

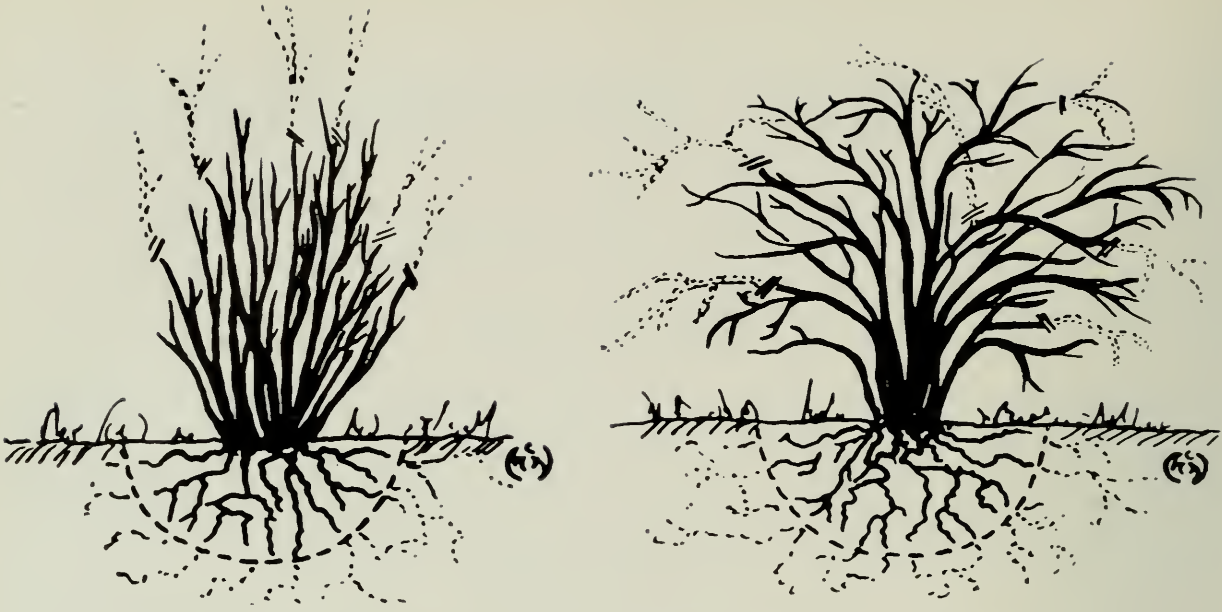
A prime objective at planting time is to do everything possible to establish the plant in the soil and to get it off to a good start. Proper pruning often aids greatly in helping a tree, shrub, or vine to survive the planting operation.

Balancing the Root System and Top

When plants arrive from a nursery, especially if root pruning or transplanting has not been practised there, they usually need some pruning at planting time to balance the root system and top. Some cutting back of the top is necessary to compensate for the loss of root system which has resulted from digging the plant. Balance does not mean the actual weights of roots and top. A more significant factor is that the loss of water to the air from the leaves of an unpruned plant may be in excess of the water supplied from the soil by a root system which has been reduced in the digging operation.

TREES. The first pruning, after trees are received for planting, consists of removing damaged or broken roots and the cutting back of the extra long or tap roots. Under no circumstances should there be a drastic shortening back of the root system to fit a small hole; the hole should always be made reasonably large.

Pruning of the top at planting time may consist, in many cases, of shortening back the branches of the head one-third to one-half to balance the top with the



UPRIGHT TYPE BRANCHING TYPE

Fig. 1—A balanced condition between root and top growth is essential.

root system, unless this was done previously at the nursery, especially if the root system is small or badly damaged. With most trees, only one leader should be left and an effort should be made to space the branches to avoid bad, narrow-angled crotches. A little shaping may be done, and this might be a good time to establish the height of the head or stem by removing unnecessary lower branches, as outlined later under "Pruning Young Deciduous Trees".

SHRUBS AND VINES. Care should be taken, as far as possible, to keep shrubs in their natural form of growth and to encourage such a condition subsequently. Some thinning out may be helpful, as well as a moderate heading back for balance with the root system. Plants for hedges are cut back much more severely at planting time than are shrubs for grouping purposes. Vines of different habits require special treatment at planting time and are discussed later in a separate section. In fact, the subsequent treatment on various aspects of pruning is to be found in much more detail than is attempted in this preliminary or introductory discussion.

Pruning Balled and Burlapped (B & B) Evergreens

Evergreens are usually dug with considerable care, are shipped in a balled and burlapped condition and, as a rule, need little or no pruning at planting time. If, after they are settled in their new quarters, they show signs of distress, the removal of part of their growth may, in occasional cases, aid in reviving them. In pines, the wilting "candles" may be shortened; in spruces and firs, the new growth, or the shoots of the preceding year (depending upon the stage of growth), may be trimmed back, except the leader which should remain untouched. Evergreens of a feathery habit, such as Chinese cypress *(Chamaecyparis)*, may receive a light shearing.

Most damage caused by handling in transit will be evident three weeks after planting. Broken ends will have turned brown, particularly on pyramidal evergreens which are much too often handled by the top. These brown ends should be removed by careful cuts with a sharp knife or pruning shears.

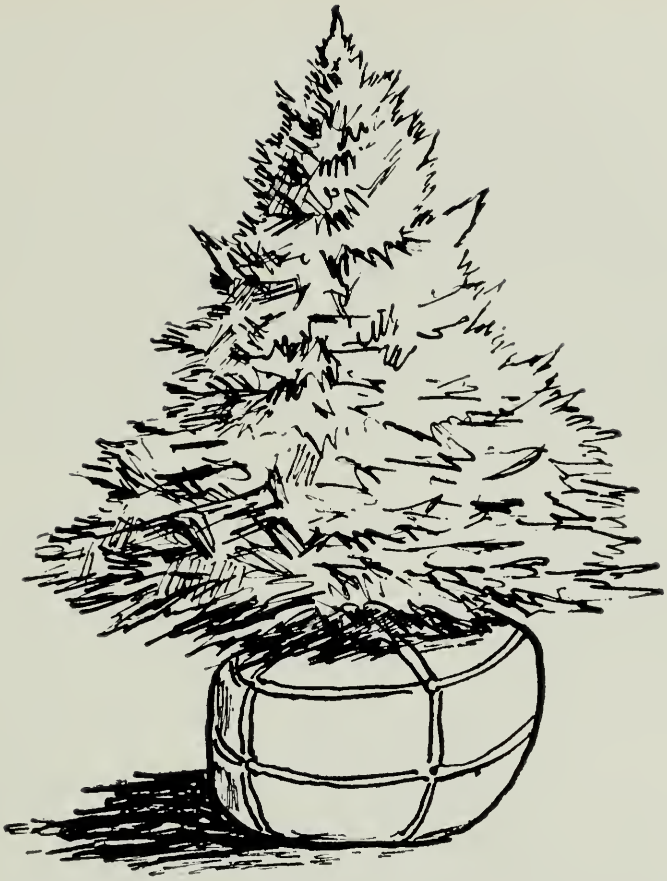


Fig. 2—A nursery evergreen tree balled and burlapped for shipment.

With spreading junipers, close packing by the shipper may result in splitting of the main branches. These splits, if attended to immediately and bound up with strong adhesive tape, will likely heal and growth will continue.

Pruning Fall-Planted Material

Fall-planted material, commonly, is best pruned in the next spring instead of at planting time, especially with species that are not fully hardy. If fall-planted material is pruned in the fall the plant may be reduced still further in size and condition by winter injury and to an extent that the pruner cannot predict. Quite often the fall pruning proves disastrous, particularly if the winter is severe. If the pruning work is left until spring the wood and buds which have come through the winter alive can be distinguished from dead growth.

Pruning to Remove Damaged or Dead Wood

Probably the first step in the pruning process which is practised by the average pruner is to remove broken, injured, dead, diseased, and insect-infested portions. Although such procedure is important, it is by no means the most significant consideration in the over-all view of pruning practice. But it is a safe beginning, and may be carried on at any time, because dead wood in tree or shrub is not ornamental and may become a harboring place for diseases and insects.

While cutting out the dead wood, the pruner should observe other malformations and needed pruning in the tree or shrub. In other words, get to know the "patient", and with this knowledge become individually interested, which is an excellent point in correct pruning. The removal of dead and damaged wood can be done at any season of the year, and to this extent makes pruning a continuous duty.

Pruning for Good Appearance and Beauty

Pruning to promote, improve, or maintain appearance and beauty is a factor of more significance with ornamentals than with orchard trees or small-fruit plantings. It is, in fact, one of the main purposes with ornamentals.

The practice of clipping and shearing each and every shrub to one familiar globe-shaped design has become prevalent in some cases. This is partly due to it being the easy way, but the practice should definitely be stopped.

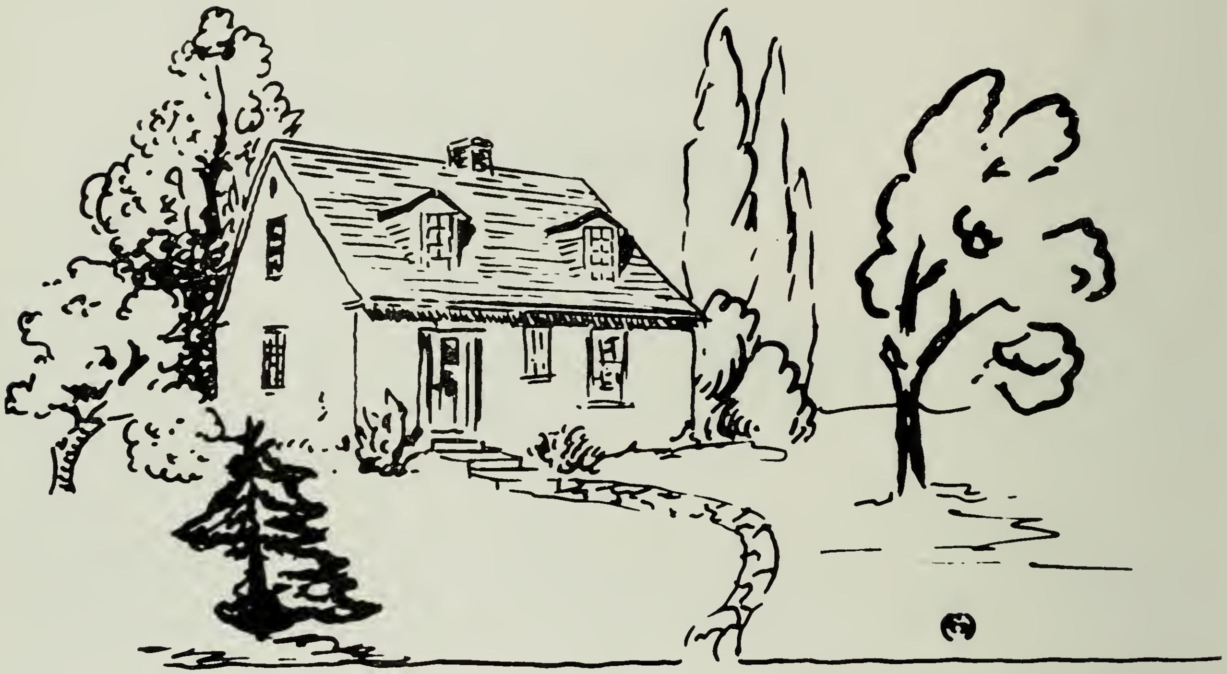


Fig. 3—Lopsided and unbalanced trees or shrubs look bad in any landscape planting.

Improving the form or shape of the plant through pruning adds to the appearance or beauty of the tree or shrub. Lopsided and unbalanced trees or shrubs look bad in any landscape planting. In modifying the form of a plant one should be familiar with its normal type shape and should not, for example, train a maple to the shape of an oak, or a spirea like a lilac. There should be a desire to observe and investigate the different growth habits, and so stimulate interest in the art of pruning or shaping the particular types to make them look natural.

Diverting Energies to Weaker Parts

A portion of the energies of the more vigorous parts of a tree or shrub can be encouraged to move to the weaker parts by means of pruning. This is brought about by a comparatively severe pruning of the branches or other parts to be subordinated. In this way a well-balanced top can be developed and maintained.

Watersprouts from the branches, although they may sometimes be used to advantage in renewing portions of the top and replacing wood that has been weakened, are undesirable responses to diverting the energies of a plant from one growing point to another. They usually indicate too severe pruning.

Topiary Art

A special type of pruning consists of training or making plants grow in the form of animals, birds, or other figures, for formal gardens. It is called the topiary art and must be regarded in the light of a horticultural fad. This form of art can be said to add humour to a garden, especially when a breeze stirs the animals to sway and dance. It is not to everyone's taste. "If you like that sort of foolishness," as Disraeli once said, "that's the sort of foolishness you like."

Training cedars, boxwood, Chinese elm, and certain other kinds of plants, to various shapes or resemblances to animals requires much patience and skill. Shearing alone does not give the desired effect. Some limbs and twigs must be controlled by tying until they remain in the desired position. A soft cord is the best material for this work, for by the time the cord rots the limb or twig has been trained.

Another special type of pruning is to make certain shrubs become tree-like, when so desired, by training to a single stem, e.g., standard forms of caragana, flowering almond, and hydrangea. Conversely, certain kinds which normally are tree-like sometimes may be trained to shrub form, e.g., Chinese elm, English beech, and hornbeam.

Twig Attractiveness

Pruning is a helpful practice in keeping attractive the ornamental shrubs which are valued for the colour of their twigs. For example, the younger wood of redtwig dogwood is more striking in effect than is older wood. Pruning promotes a supply of such desirable new growth.

It is sometimes the practice to cut back the plants to stubs and let them send forth each year a "crop" of bright-coloured stems, e.g., willows; and over-sized leaves, e.g., catalpas.

Pruning for Good Floral Display

An important purpose of proper pruning in many kinds of plants is to increase the size of flowers and fruits without at the same time causing too great a reduction in their total quantity. This may be accomplished by removing the thin, slender weak wood, and retaining that which is naturally strong, thick, and stocky. The term "thin-wood method" is descriptive as well as designative of such pruning.

Also, by reducing the number of growth buds on shrubs which produce their flowers on shoots of the current season, it is possible to develop larger flowers on longer stems. Certain pruning procedures help to lengthen the period of bloom, such as cutting off the flower heads of various so-called everblooming kinds, e.g., certain roses after the blooms have faded.

Root Pruning to Overcome Shy Blooming

Root pruning is a good treatment for shy-blooming established plants. Root pruning, in this case, is merely the shortening of roots in the soil to check top growth and to stimulate the formation of branch roots nearer the trunk. Checking growth may increase flower production or, in the case of delay in coming into bloom, encourage the formation of flower buds.

In order to prune the roots of an established plant, a spade is thrust into the soil, encircling the plant and cutting the roots at a distance reached by the spread of top growth. When a tree needs root pruning, a circular trench may be dug deep enough to sever the lateral roots. This is an extreme measure, yet the florist commonly resorts to a corresponding procedure when he promotes a pot-bound condition in his plants. (See also later, "Pruning Tardy Blooming Shrubs").

Pruning to Control the Height and Width

Any planting that is planned for effect, such as the foundation planting of a home, a base planting around a feature, or a background planting for a border, if allowed to grow naturally will eventually become too thick or too high no matter how carefully the material is chosen, unless some measure such as pruning or the removal of alternate plants is carried out.

A planned programme of pruning would prevent many "leggy" specimens of lilacs. It would also keep evergreens in neat and tidy condition, and would insure a stronger, cleaner structure of shade trees. Vigilance by constant pruning would keep better proportions in landscape effects, and it is far better to be continually watchful and give prompt pruning than to allow growing spells to be ended abruptly with drastic pruning spasms.

Dwarfing Effect

Pruning exerts a dwarfing effect, both on the top and the root system, more particularly on young plants than on old ones, and more so if done in the growing season than in the dormant season. The immediate effect of pruning is to increase the length of growths and size of leaves, but total growth as measured by total size, weight, or trunk circumference, is greater with least pruning.

Pruning reduces the number of shoots that will grow, thus causing each remaining shoot to grow more vigorously, although the total growth is less. The increased vigor is merely the response of the plant to heavy cutting, and the use of reserves in making this growth.

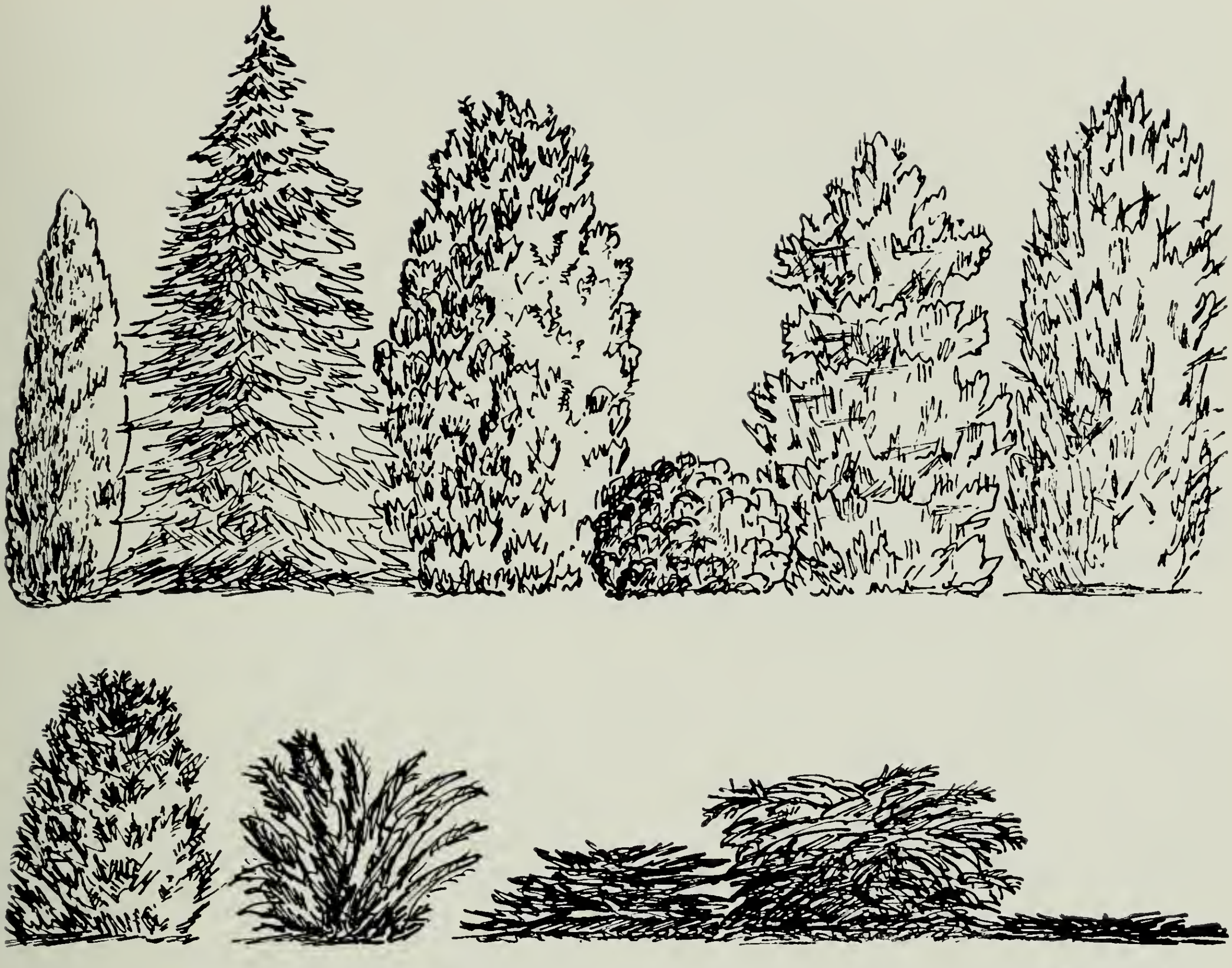
Minerals are taken into the roots in solution and are transported through the plant to the leaves. The nutrients then combine with the carbohydrates (made through photosynthesis) to form the proteins and other plant foods which are used in growth. Cutting away a live part of the plant which, if left, would have borne leaves, or is in leaf, reduces the output of the "factory" and so reduces total growth.

Adjusting to the Surroundings

Pruning is a means of helping the tree or shrub adjust itself to its surroundings. That is, the same species may be lightly pruned and allowed to become quite large where there is ample space for it, or by more severe pruning it may be kept smaller for closer planting but at the expense of less bloom.

Low Branches on Street Trees

It is often desirable to remove low-hanging branches on street trees, or on various trees planted on grounds, so that they will not interfere with traffic or when walking under them. A further consideration is the removal of branches of street trees that interfere with the utility wires, and to avoid hazards to life and property from falling branches. (See also later, "Pruning Young Deciduous Trees").



These diagrams show the shapes of evergreens. Top left to right, white cedar, spruce, Austrian pine, mugho pine, Scotch pine, red cedar. Bottom left to right, yew, Savin juniper, tamarisk-leaved juniper, Pfitzer juniper, Andorra juniper.

Fig. 4

Evergreens

Evergreens, particularly, are sometimes necessarily controlled to keep them within bounds both in width and height.

Mugho pine, globe cedars, and boxwood should receive an annual trimming (not too severely formal), unless required for natural effect. This should be done every spring when growth is starting. Then in midsummer all stray growths that have appeared can be cut back, and in this way these bushy specimens can be kept in compact form without losing their natural beauty.

The spreading type of evergreen, for example juniper and yew, should receive monthly attention during the growing period to correct any wayward habits and keep the branches free from brown foliage and other unsightly effects that arise from neglect.

Pyramidal types should be kept pyramidal by a light clipping or shearing in May and August and not left entirely to their own devices. They received this treatment in the nursery (or should have received it) and there is no reason why it should stop after planting.

Pruning to Regulate the Condition of the Plant

It is wise to work on some kind of time schedule (at considered intervals) for correct pruning. This timing programme may need to be speeded up when neglected trees or shrubs must be dealt with, otherwise very drastic measures may result in "battlefield" appearances. Too severe pruning results in sucker growths, hence wisely regulated treatments will gain better effects in appearance, performance, and health conditions of the plants.

Thinning Out and Heading Back

Thinning-out pruning is the removal of an entire shoot, branch, or limb, the cut being made where these grow out from the parent stem structure. Heading-back pruning refers to the removal of only the terminal portion of the shoot, branch, or limb, leaving the basal portion intact.

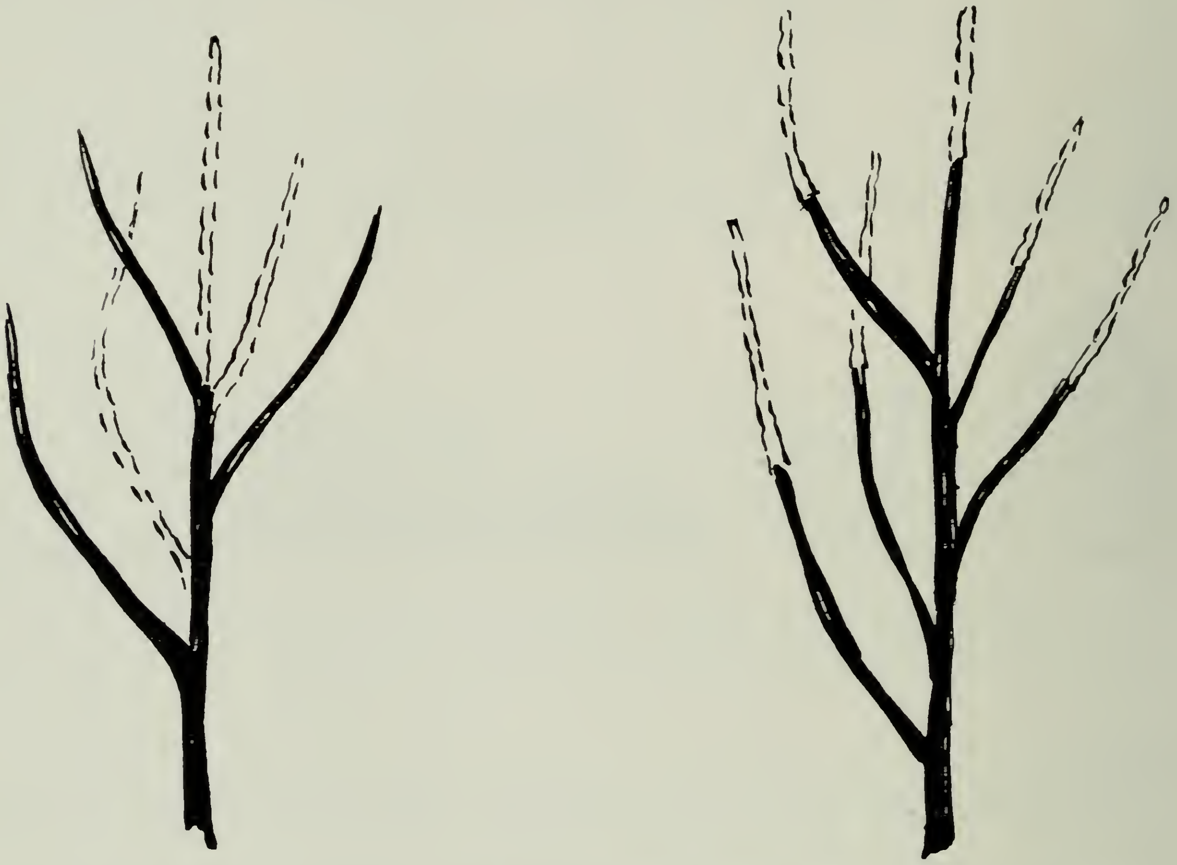


Fig. 5—Thinning out (left) and heading back (right); 50 per cent in each case.

A tree or shrub may be pruned with equal severity by either thinning out or heading back. Usually, the two methods are combined, but thinning out may predominate to advantage in some cases and heading back in others. In hedges, for example, heading back predominates and serves to restrict the growth, making it less rangy, more dense, and compact.

In cases where plants produce their flower buds terminally or subterminally on shoots, e.g., lilacs, general heading back results in a drastic reduction in flowering. The thinning-out method should predominate in species that are grown for their flowers or for the colour and texture of the foliage, rather than for their geometrical form, except in such cases as mopheaded catalpas, standard hydrangeas, or controlled forms of flowering shrubs.

Localized Influence

Any individual pruning cut is necessarily localized and, though it may have a slight influence on the entire plant, its chief influence is on those shoots, branches, or other parts in close proximity to where it is made. Hence, pruning is properly done close to where the response that it is hoped to obtain is wanted, for example, on one side, in the top, or in the centre of the plant, as the case may be. Removal of a comparatively large number of small branches results in a more general response than does removal of an equivalent or even greater amount of wood in fewer branches. In other words, more cuts scattered may be better than a few drastic cuts.

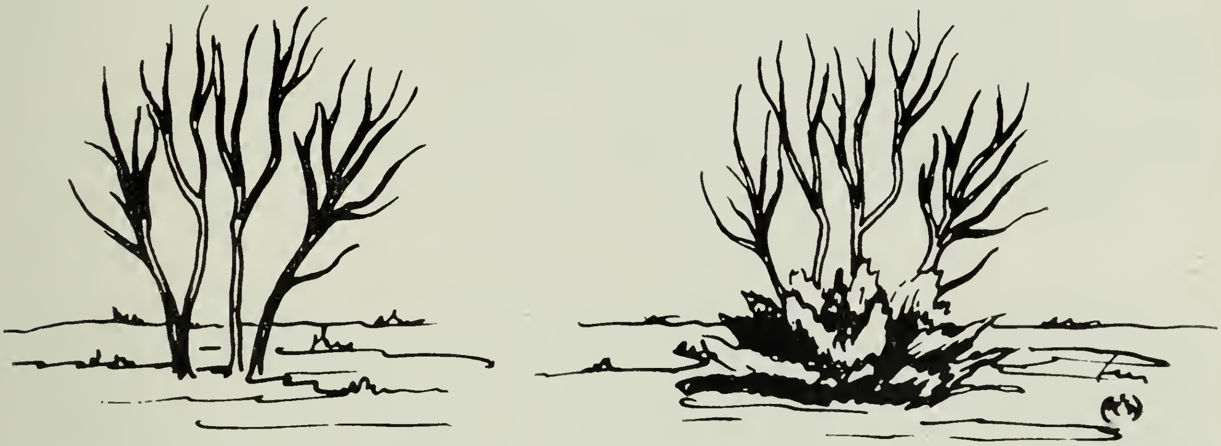


Fig. 6—Many shrubs are unbranched at the base. To hide the bare portion, lower-growing shrubs may be planted in front.

Renewal or Rejuvenation of the Plants

When shrubs are neglected for several years they present a much more complex problem than those that have received regular attention. Many of the taller growing shrubs, even if pruned properly, appear as if they had been pruned up from the bottom. To bring them "down to the ground" such shrubs may require lower-growing shrubs planted in front.

Pruning to Increase the Structural Strength

Pruning to increase the structural strength should start when a tree or shrub is young, or at the time of planting. A narrow or Y-angled crotch,

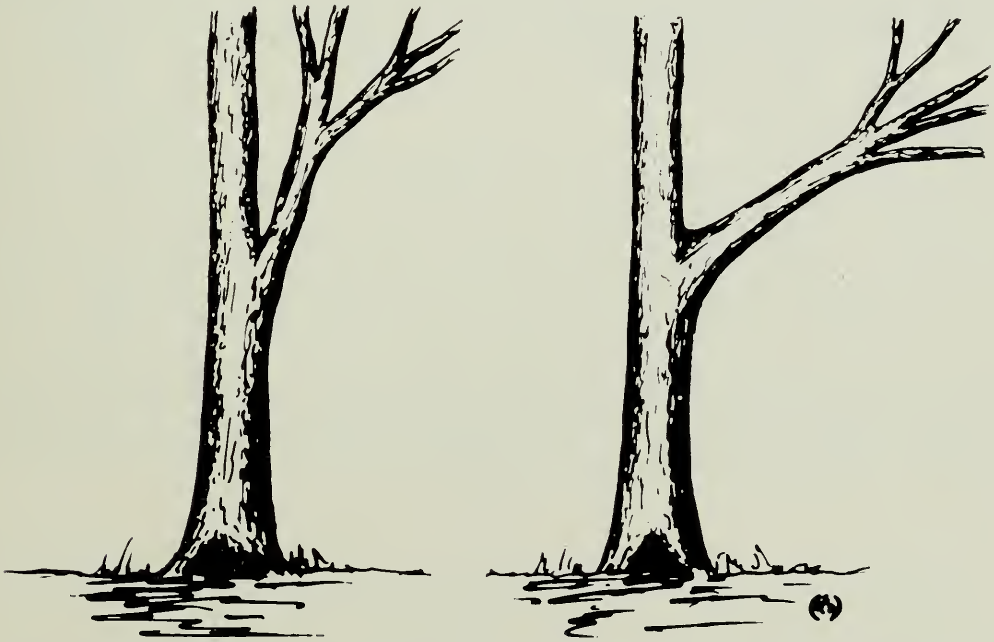


Fig. 7—Narrow-angled, weak crotch (left); wide-angled, strong crotch (right).

especially when branches are growing upright, is an undesirable condition from the standpoint of the structural strength of a tree. When a crotch is wide angled, the branch can usually be bent considerably downward without breaking.

A wide-angled crotch is much stronger than a Y-crotch, and efforts should be made, so far as possible, to eliminate the latter type of weakness in the branches. There are at least two ways of correcting this condition:

1. By cutting out one or other of the competing branches in the "Y" in a recently set tree. Though there may be a crook in the trunk for a time, subsequent growth will largely, or entirely, correct this.

2. Subordinating one of the competing branches, perhaps by heading it back to an outside bud.

WHEN TO PRUNE

The old adage to the effect that "pruning may be done any time the knife is sharp" is subject to limitations. As one example, to prune in autumn may encourage new growth that may not mature before winter and so be subject to winterkilling. Another example is that good prospective flowering branches may unwittingly be removed if the time factor is not recognized. However, broken branches should be removed promptly after the breakage occurs. There is little reason to delay such work. In fact, leaving broken branches on trees may be dangerous to passers-by, and a clean-cut amputation heals more readily than does mangled tissue. Also, in budded or grafted specimens, sucker growths should be eliminated as soon as noticed.

Intervals

Frequently some pruning each year is necessary with many kinds of plants. But in certain cases pruning only at a longer interval is the most efficient practice. Also, there is much unnecessary pruning done which could have been avoided if the trees or shrubs had been properly chosen to fit their particular site.

It is better that the trees or shrubs be pruned annually by small cuts than infrequently with subsequent larger cuts. The larger cuts take longer to heal, may promote many suckers, and bring about other undesirable effects.

Pruning in Early Spring

Early spring, in the dormant season just before growth begins, is probably the best general time to prune deciduous trees, vines, and certain types of shrubs. When the leaves are off, the outline or framework of the plants is in better view than it is later. The wounds not only heal comparatively quickly in the spring but are less likely to infection from disease organisms or infestation with insect pests. Large trees are not barked easily when pruned in the spring, and at this time there is least danger of bark peeling away around pruning wounds. Pruning during winter can be done more readily and safely in comparatively mild areas than in very cold ones. It is not advisable to prune while the wood is frozen, nor is it comfortable for the pruner and might prevent that deliberate consideration which is necessary for careful pruning.

The correct time for pruning shrubs, and the manner in which it is done, depends greatly (as discussed in a subsequent section) upon the flowering season of the species. Generally speaking, spring-flowering shrubs should be pruned soon after flowering. This avoids the destruction of the prospective bloom and allows new shoots, that result from pruning time, to mature. But shrubs that bloom in the fall on wood of the current year can be pruned in early spring, which still is, of course, after they have flowered.

"Bleeding"

Certain trees, such as maple, birch, walnut, and mulberry, "bleed" profusely when pruned in early spring, and the pruning in such cases should be delayed until somewhat later. However, although the bleeding (which might be compared to tears in humans) is messy and otherwise objectionable, it seldom causes serious damage and the sap loss stops when the leaves appear. Pruning of species that bleed badly should be done comparatively late in the spring, or considerably in advance of early spring; large cuts should be particularly avoided and, if they are made, should be promptly coated with a suitable covering.

Winter Injury

Quite often, severe damage to plants by winter conditions results as a direct cause of pruning in autumn. Also, if ornamental trees and shrubs are pruned in autumn, species that are not 100 per cent hardy may kill back so that further pruning is again needed in the spring, and thus the total reduction would be greater than was intended.

PRUNING DECIDUOUS TREES

Nurserymen who supply stock of good structure give considerable attention to proper pruning before the plants are sold. This structure should be maintained and kept to the lines of its initial training.

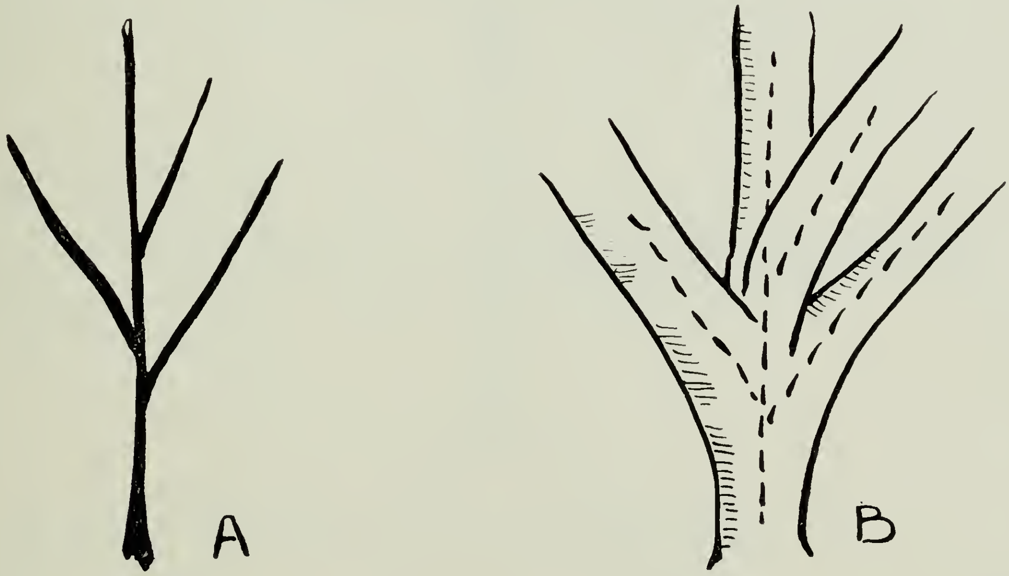


Fig. 8—This is a diagrammatic representation showing, A, scaffold limbs 2 to 3 inches apart that appear to be well spaced while the tree is still young but with, B, an enlargement of the trunk and branches as the tree grows. This spacing proves insufficient and crowding and weak crotches result.

Pruning Young Deciduous Trees

The natural forms of shade and ornamental trees are desirable. Except for the removal of any sucker growth from the base of the trees, and the cutting out of cross-growing branches and other corrective procedure, pruning is usually less essential than with orchard trees. But for a period of years after planting, young trees should be watched, and measures taken to correct, any undesirable trend to crookedness in stem, forked or double leaders, or too-narrowly-crotched branches.

Sometimes the stems of young trees produce many short leafy twigs. These can be left on for a number of years but should not be allowed to develop into growths that would cause scars when cut off.

When the trees have reached a height of about 15 feet, the lower limbs should be removed to leave a 7-foot clearance from ground level. This clearance can be heightened eventually to 10 feet.

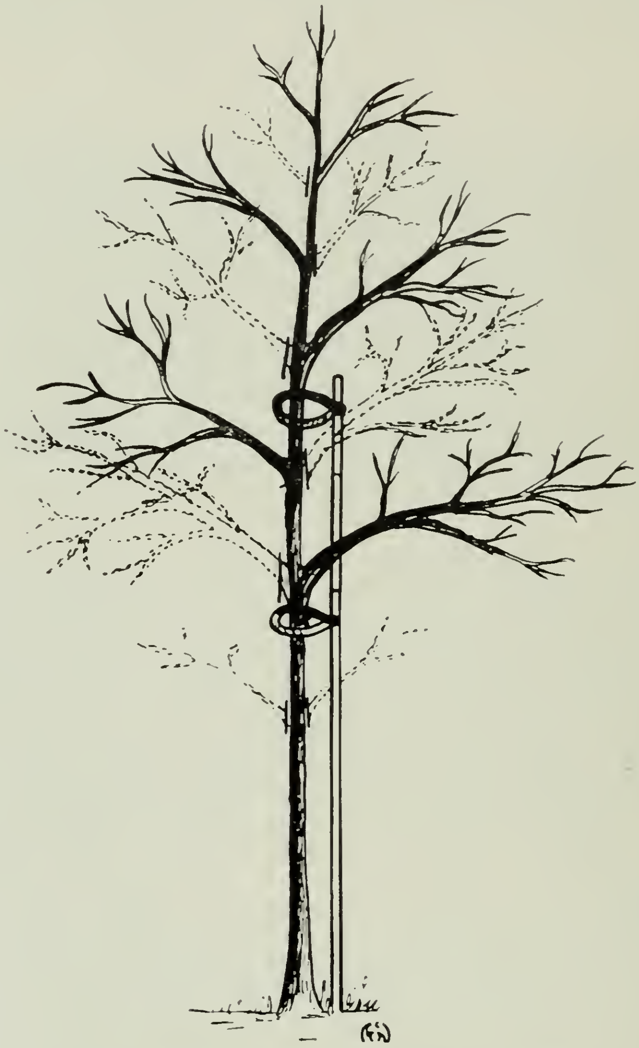


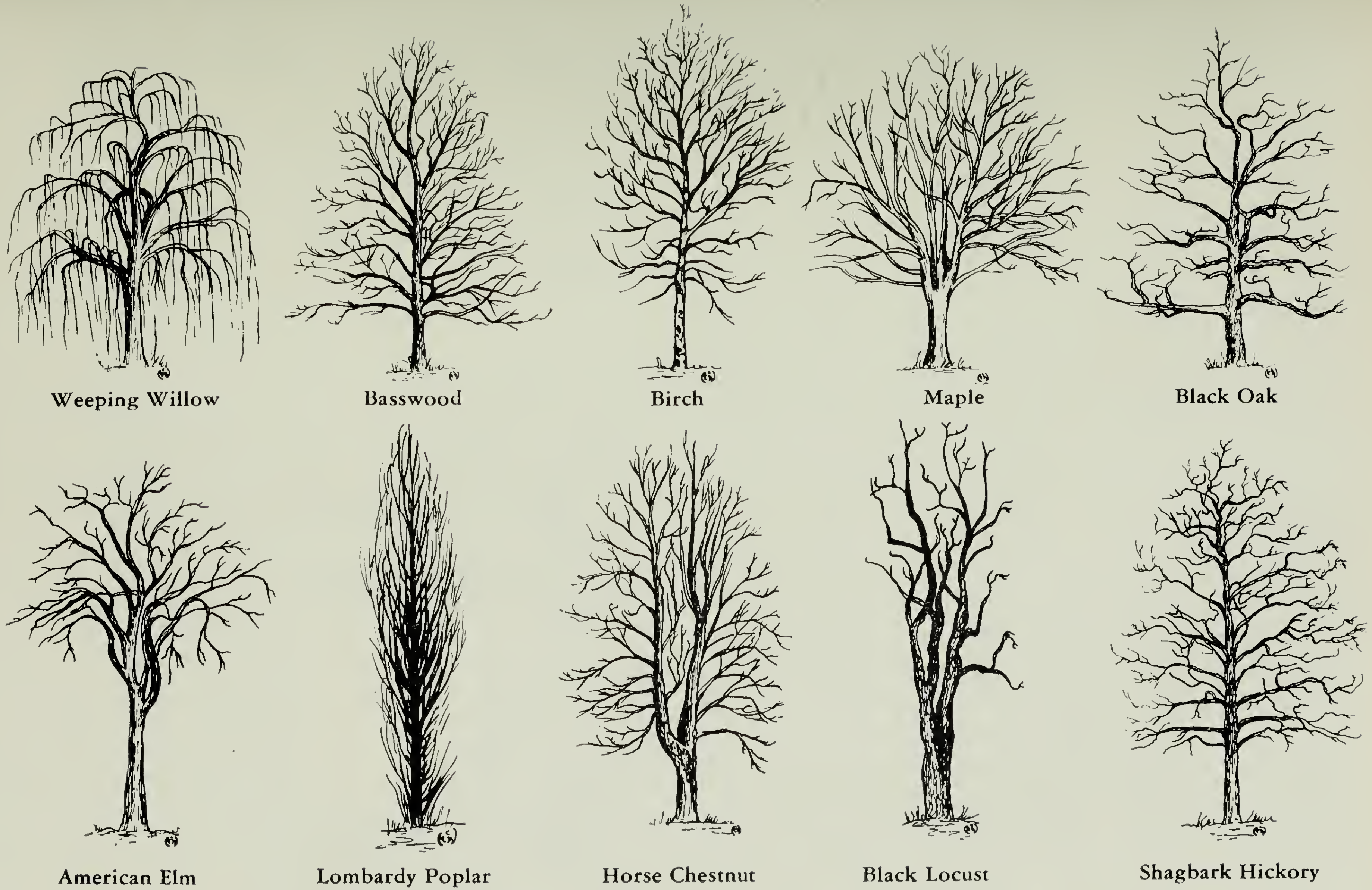
Fig. 9—Branch removal at planting time.

Pruning at Planting Time

The top should be balanced with the root, as explained earlier. A careful removal of branches should be carried out (Fig. 9).

Growing Habits

Certain trees, such as Norway maple, are spreading in habit and without a conspicuous dominant leader. There is a more definite leader in red oak and white oak. The American elm, especially in areas where it grows quite large,



Good pruning of ornamental deciduous trees requires familiarity with their growth habits.

Fig. 10

commonly develops with no well-marked leader. Silver birch trees have graceful lines and should be allowed to develop naturally. Beech trees are more horizontal, with a dense interior, and with less accent on the leader. Ginkgo, poplar, and tulip tree usually have well-defined, straight leaders, whereas the horse chestnut's claim to beauty is its domelike structure. Hard maples divide and subdivide until there is a veritable thicket of leaders. Each family of tree, therefore, should be familiar to the pruner, not only in the early growing habit but with the later development in the top which follows in after years in the different species.

Pruning Mature Deciduous Trees

If pruning is necessary to control the size of the tree after it has reached maturity, or to renew its vigour, this generally implies that a wrong choice in position was made in the species of tree at the start. But if neglect has caused serious obvious irregularities in the structure it is better to make some attempt at correction, carrying out the program of removal of heavy limbs over a period of 2 or 3 years instead of too drastic a pruning operation.

Removing Large Branches

Large branches should be removed by cutting close to, and parallel with, the axis of the parent branch or trunk. The object of this is to make the wound close to an active part of the tree so that it may quickly be healed over by the growth of the callus tissue. If stubs are left, they are almost certain to die because there is no flow of sap through them. When the stubs die, decay will set in which may extend into the trunk far beyond the original stub.

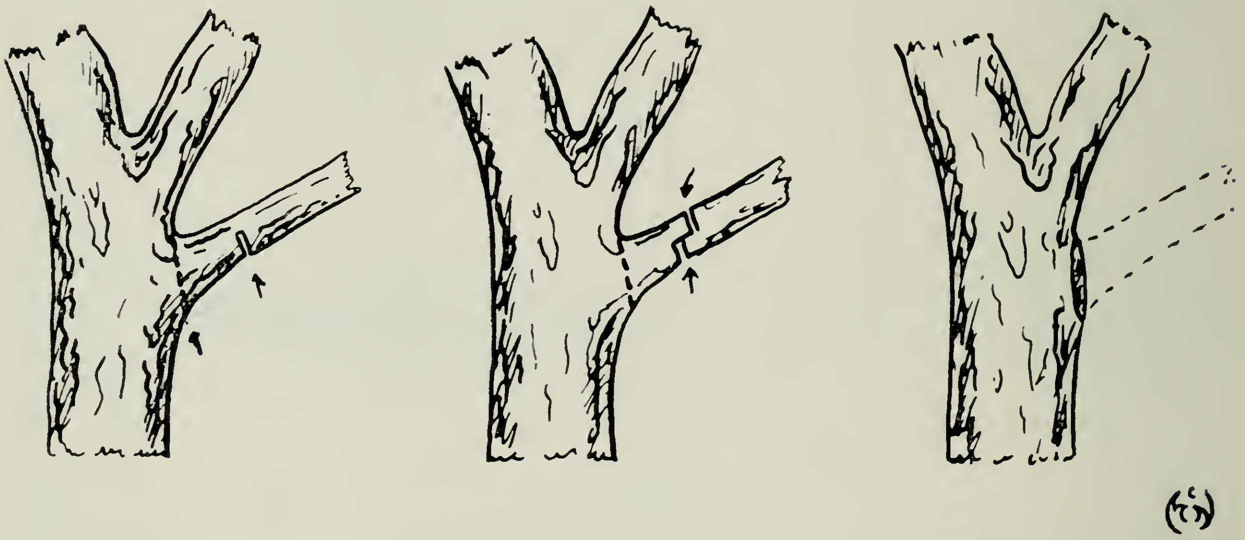


Fig. 11—Removing a heavy limb by means of three separate cuts.

When cutting out heavy branches, grave injury to the tree may result if certain precautions are not taken. The tree may suffer considerable damage if only a single removal cut is made in a large branch, for the weight of the limb soon becomes too great to be supported by the remaining wood and much of the bark below is ripped off.

Wound Dressings

It is usually wise to treat pruning wounds that are over 2 inches in diameter. Until such a wound is completely calloused over it remains unprotected from cracking and weather influences; it is susceptible to attack by fungi that cause wood rots. Rapid healing of pruning wounds and the lasting qualities of any dressing used are therefore important. The readiness with which a wound heals is correlated to healthy tissue surrounding the wound, nature of the wound dressing applied, and time of year when the wound is made.

The ideal dressing should be non-injurious to cambium and should protect the exposed wood against moisture and decay-producing organisms while healing. It should not melt and run in summer or become hard, crack, and flake in cold weather. It should adhere to fresh wounds and be easily applied. For use in connection with certain diseases, the ideal dressing should be toxic to the causal organism but should not injure the tree.

Shellac applied immediately after the cut is made is an excellent foundation covering. Its effect, however, is short. But a longer-lasting coating, such as a paint, can be applied on top of it with less damage to the tissues than would otherwise occur (turpentine in paint kills exposed cells). Certain trade materials, such as "Braco", give excellent results. Grafting wax is fairly good but is by no means ideal. Wound dressings sometimes are used which, though only slightly toxic, have an injurious effect on pruning wounds, and the hazard of such dressings may be greater than that from possible heart rot injury.

PRUNING NEEDLE EVERGREENS

Evergreens or conifers require pruning just as much as other woody ornamentals. Most persons consider it a violation to cut back or trim the beautiful new growths and fronds of choice evergreens. Often it is good pruning practice so to do, for in the case of spreading junipers if the heavy frondage is allowed to reach out too horizontally it is easily broken under the strain of heavy snow in winter and in time the centre of the plant becomes denuded of any green foliage and a sprawling octopuslike shape develops. With pines and spruces the branches reach out for sunlight and the part nearest the main stems becomes bare and unattractive.

A careful controlling or early pruning of the terminals in their young state is often the answer. But a later adjustment can be made in junipers by undercutting and allowing fresh terminal growth to overlap the pruning cut. Evergreens should only be pruned by a skilled, observant, or well-informed operator, for cuts badly made are irreparable.

Training a New Pine or Spruce Leader

Sometimes the leader of a pine or spruce tree is accidentally broken. A new leader may be trained up by selecting a strong side branch from the upper whorl of branches, bending it upward carefully, and tying this securely to a stiff stake. Care should be taken to tie the string in a knot to the stake first, then loop around the new leader and gently pull it towards the stake, leaving plenty of leeway for the new growth expansion which is likely to be vigorous. It may be wise to make a few adjustments from time to time.

Shaping Mugho Pine

In shaping mugho pine much depends upon first obtaining the true, dwarf, many-stemmed type. To maintain the plants in a compact growth, the pruning should be done annually just before the buds open. Normally, each branch makes a shoot or candlelike growth of 2 to 6 inches. If warranted, two-thirds

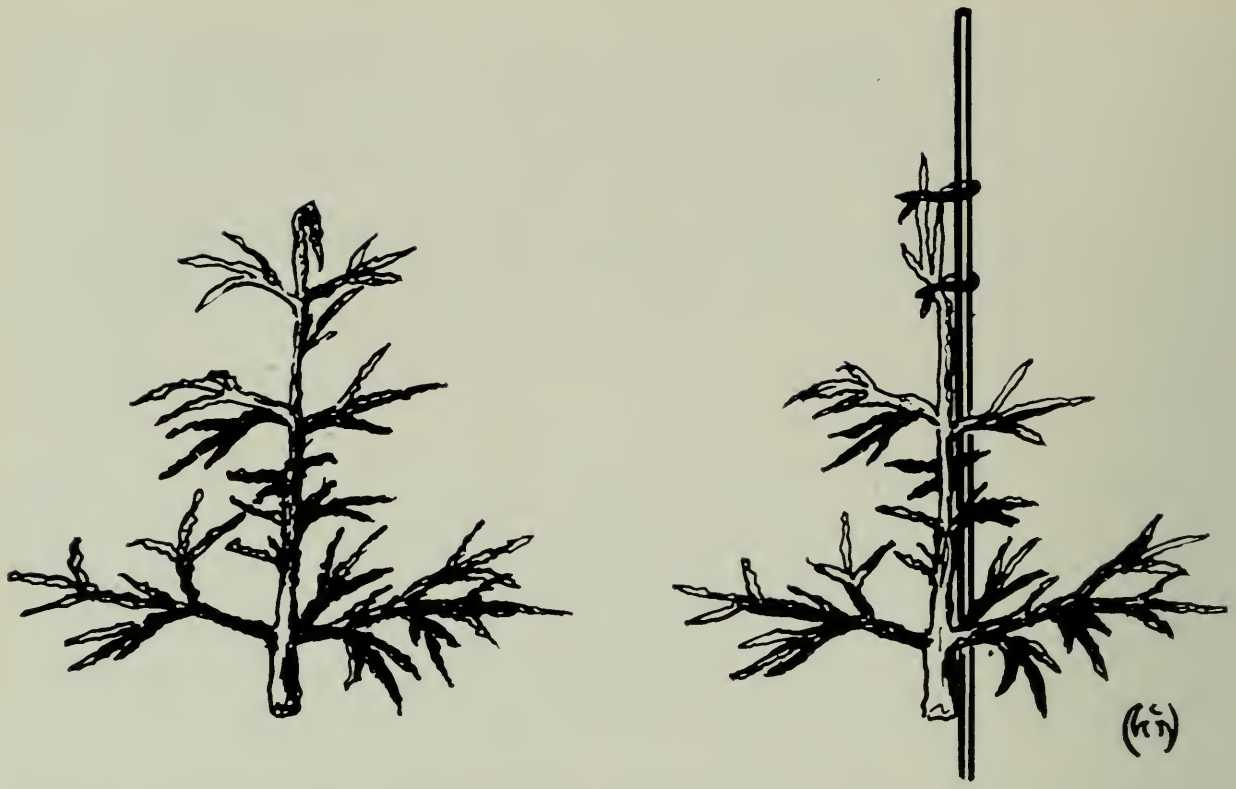


Fig. 12—Broken leader (left); new leader trained up and tied to a stiff stake (right).

or more of this growth should be cut off, otherwise the plant will grow with a loose habit. It is not possible to change the loose habit of mature plants back to a good compact form by means of pruning, and attempts to do so may prove disastrous.

"Plucking" Evergreens

Certain young pine, fir, and spruce may be made denser and more uniform in appearance by removing the terminal buds of the stronger branches. This is called "plucking". It forces the side buds to grow and also helps the weaker shoots to make more growth. The buds should be removed in early spring just as new growth starts.

Pruning Established Evergreen Trees

Great care must be taken with respect to pruning established evergreen trees because of the time that has been involved in their growth. Trees that have taken a long time to develop can be ruined in an hour by careless cutting. It is more than ever necessary to know the natural habit, shape, and peculiarities of the specimens to be pruned and to spread the pruning programme over a number of years.

Preserving Symmetry and Beauty

If the lower branches of fir, spruce, and pine are removed, the trees look unnatural. Evergreens do not send out sprouts as do the broadleaf trees, and so there is no way of replacing branches that have been removed.

The beauty of most of the tall upright spruces and firs lies in the whorls of branches that radiate like spokes in a wheel, tier upon tier, and in their tapering symmetry. The limbs should be left intact from the ground up so that the

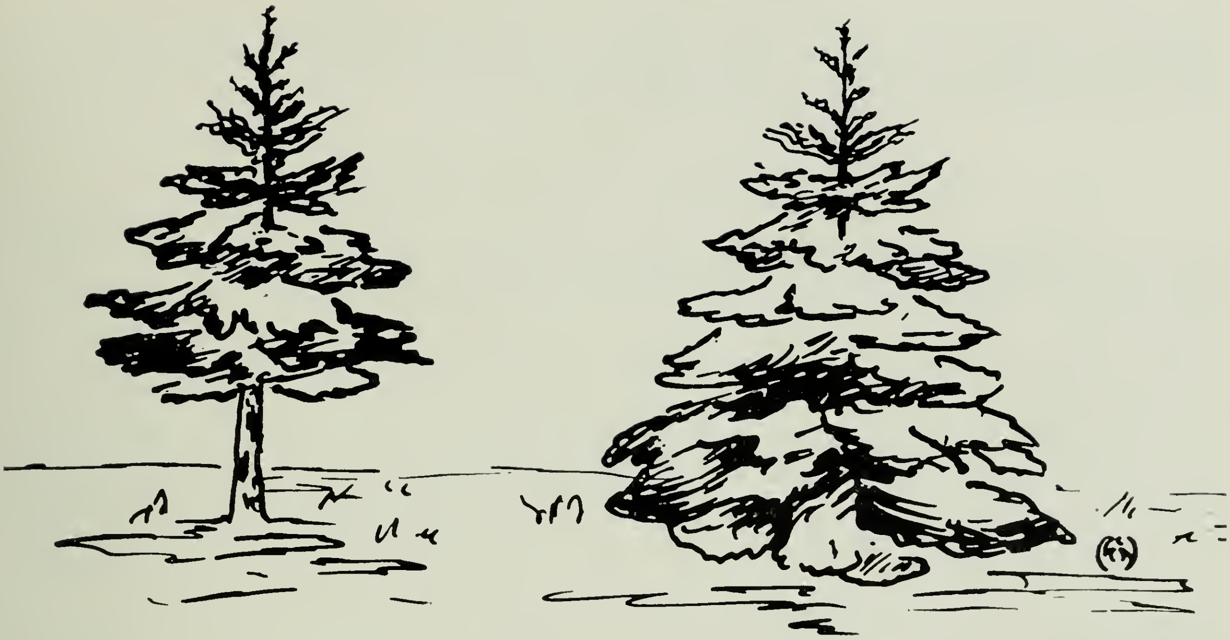


Fig. 13—In needle evergreens it is desirable from the standpoint of symmetry and beauty that the limbs be retained from the ground up.

symmetry and beauty of the trees are not marred. If the widesweeping lower branches are removed, the beautiful tapering effect is lost and the chief beauty of the tree is gone. Therefore, no entire branch should be removed from an upright evergreen unless it is dead, diseased, or with scant foliage.

If a branch needs to be shortened, as may happen if the tree is one-sided, the pruning should be done in the early spring and should include one or two years' growth. If the branch is cut below the foliage line, it will seldom succeed in forming new growth and it is better to leave a margin of safety. To obtain this beauty it is worthwhile giving more care to evergreens when in the immature state by attention to cultivation, use of fertilizer, and watering.

Shaping Soft-Foliaged Evergreens

White cedar (arborvitae), yew, and juniper, which possess rather soft foliage, can be shaped by shearing. This type of pruning may be done early in the growing season and again in midsummer, provided sufficient growth is made to warrant it. The long-bladed hedge shears are well adapted for this purpose. This method is primarily employed when the trees are being used in formal gardens, or other formal developments, and for making young trees denser. If an informal shape is desired, the tree should not be sheared more than twice, preferably when it is small.

Branch Pruning of Junipers

The informal type of juniper, whether it be spreading or upright in habit of growth, frequently needs some branch pruning to keep it within bounds. The long branches are cut just above a vigorous side shoot on the second- or third-year wood. Having all the branches the same length should be avoided as that would destroy the irregular, informal outline which is to be desired.

Covering Pruning Cuts on Evergreens

Pruning cuts on spreading evergreens should be hidden by part of an overlapping branch. This avoids the unsightly appearance of exposed cut surfaces.

The resins and other materials in evergreens provide protection for pruning cuts. Therefore, wound coverings seldom need to be applied on evergreens but they may be helpful in the case of very large cuts.

PRUNING BROAD-LEAVED EVERGREENS

A number of interesting broad-leaved evergreens are becoming increasingly popular in landscape work, and so need more general consideration with respect to pruning.

Ground Covers

Fairly hardy broad-leaved evergreen ground covers include wintercreeper *(Euonymus radicans vegeta)*, Japanese spurge *(Pachysandra terminalis)*, and periwinkle *(Vinca minor)*. These plants are improved by being headed back with individual cuts to form dense mats and to prevent new growth from strangling any plants near by.

Shrubby Types

Some frequently planted shrubby types of broad-leaved evergreens include boxwood *(Buxus)*, daphne *(Daphne cneorum)*, pachistima *(Pachistima Canbyi)*, firethorn *(Pyracantha)*, hollygrape *(Mahonia)*, and certain species of barberry *(Berberis)*. These shrubs recover rather slowly after being moved, hence they benefit from a fairly severe pruning at transplanting time. Subsequently they require little pruning beyond the removal of straggly growth and winter-injured or dead wood.

Rhododendrons and Azaleas

Rhododendrons and azaleas grown in northern climates should be pruned very lightly if at all. Whatever pruning is undertaken should only be done if it is found necessary to improve or alter the shape of the bush. The best time to do this is before the young growths have set terminal buds in July. At least three leaves should be left at each young stalk, but even then the chances are that some kinds of rhododendrons will not be able to set well-matured buds before fall if the season happens to be short.

The heads should be broken off carefully before seed capsules have formed. But this work should be done very carefully as young growth is formed from buds right under the flower heads. If there are too many young shoots crowding one another these can be cut out later in the season when it can be determined which have set flower buds for the next year and which have not done so.

Azaleas, especially the Japanese types, can be headed back quite successfully during the early growing season and still form flower buds.

Kalmia and pieris, which also require a special acid soil, are pruned much like rhododendrons.

PRUNING ORNAMENTAL SHRUBS

When large shade trees need pruning it is customary to call in tree experts with their special equipment. For fruit trees a knowledge of pruning by the pruner should be an accepted fact, evergreens require experienced hands. But, ornamental shrubs seem to be everybody's field!

Pruning of ornamental shrubs should be a most interesting instructive experience for any garden enthusiast, but knowledge of the shrub to be pruned is essential. The "Basic Reasons for Pruning" have already explained that this is imperative. It is now necessary to know how to proceed.

Pruning Shrubs in the Dormant Season

The wise man will preferably wear overalls, select good pruning tools, and spend a reasonable time in "sizing up" the specimens to be pruned. He will cut out all dead wood, and cautiously proceed to prune for structure, shape, supply of bloom, and other prime purposes, remembering that what is cut off cannot be put back again. "Better to be sure than be sorry" should be the motto, and one should classify oneself more as a surgeon than as a butcher. And as with the surgeon, his services should only be sought when necessary. Too many persons prune for the sake of pruning.

Better Visibility of Framework

Pruning in the dormant season (late March or early April) offers the advantage of bare shrubs with better visibility of the framework. The pruner can more easily see what he is doing in the centre of the plants at this period. He can select the older, weaker growths as well as the damaged or dead parts which are to be removed, and give more time to the work as at this time other gardening activities are not pressing. Before too much wood is cut out it is wise to stand back and examine for shape.

The removal of portions that have been winter-killed may, and often must be, delayed until leafing out has determined the extent of the injury. But it should not be put off longer than is necessary.

Most, if not all, trees and shrubs which are not valued for their bloom are probably best pruned in the dormant season.

Shrubs That Bloom in Late Summer or Early Fall

Hybrid tea and hybrid perpetual roses, Anthony Waterer spiraea, hills-of-snow hydrangea *(Hydrangea arborescens)*, peegee hydrangea *(Hydrangea paniculata grandiflora)*, clethra, hibiscus, kerria, and tamarix bloom late on growths made during the current season. These late-blooming shrubs produce flowering wood that blooms in the same year because their flower buds are not produced until the new growth is made.

If these plants are cut back soon after bloom they may send up tender shoots which winterkill. Plants of this kind need a heavy pruning shortly before growth begins in the spring. Only a few of the healthiest canes are left and these are cut back to a point just above the second or third bud on last year's growth, choosing an outward bud where possible. This promotes strong new growth and consequently large blooms.

Pruning Shrubs After Bloom

Pruning after bloom is not as widely practised as should be the case. Many shrubs which are grown largely for their flowers are best pruned just after bloom and before new buds form. This means the pruning of spring and early summer flowering shrubs when in active growth.

Pruning in the growing season properly begins a week or so after the earliest shrubs, e.g., forsythia, have finished blooming. When the later shrubs, e.g., spireas, mockorange, and so forth, pass the bloom stage they too should be pruned shortly afterwards. But shrubs that bloom in late summer or early fall on growths made during the current season are not pruned shortly after bloom for reasons given earlier.

Pruning after bloom promotes the production of young healthy wood with a resulting full bloom the next year. In many cases it regulates the bloom for the next year to better advantage than does pruning in the dormant season, and it also allows maximum bloom of the shrubs to be enjoyed.

Removing Seed Heads

The natural habit of a shrub after flowering is to develop seed. In some instances, for example, rose species, the hips are attractive, but in most species of shrubs the seed heads become unsightly. Prominent examples here are lilac, mockorange, and weigela.

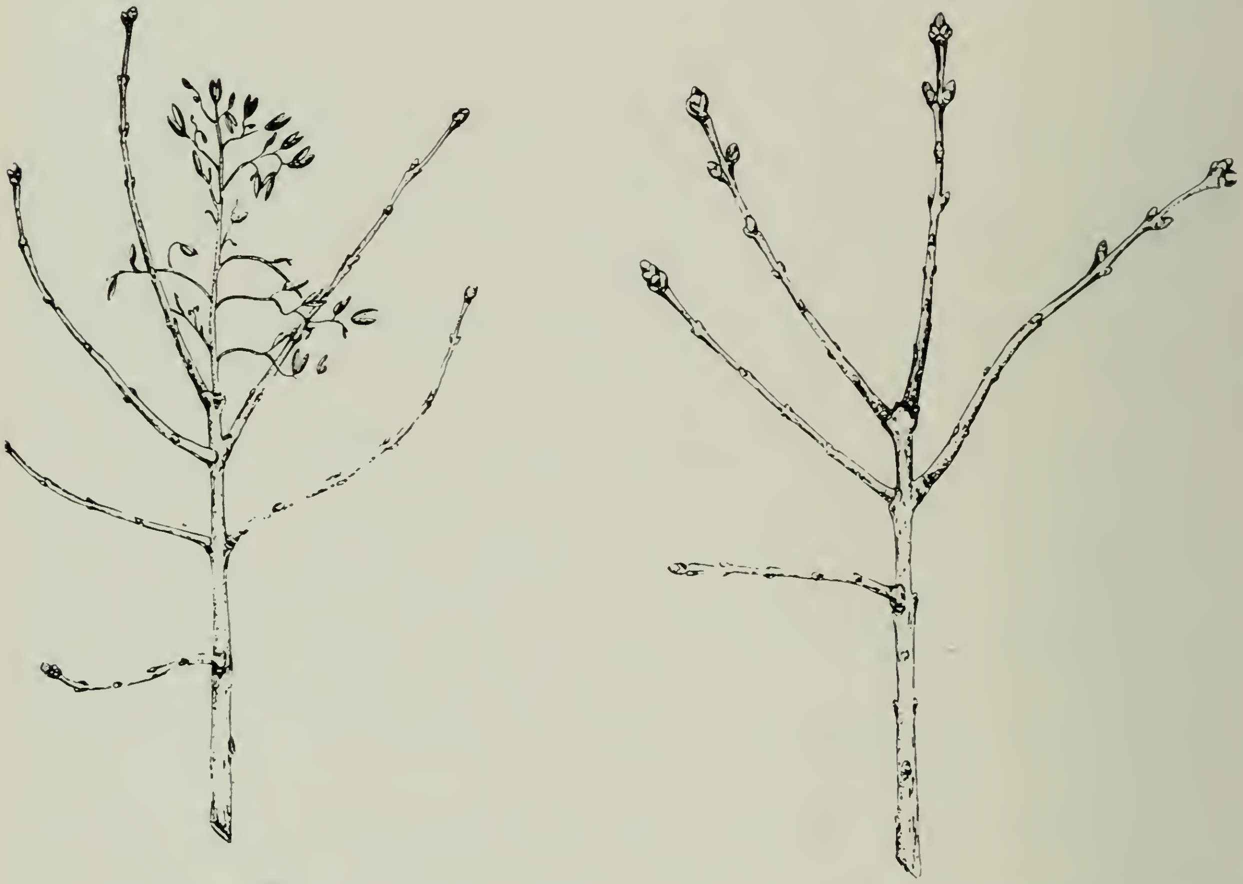


Fig. 14—Seed heads, as in the lilac, exert an exhausting effect. They should be removed soon after bloom, taking care not to injure the newly-forming buds which will then develop into desirable growth.

After the flowering season, the old flower heads of lilac should be clipped off and any necessary thinning out of the branches be done. The seed heads, if left on the plant, exert an exhausting effect through seed development. Care should be taken when cutting off these seed heads not to injure the terminal bud-growth that may be developing. Heavy dormant pruning may interfere seriously with the flowering habits of this popular shrub, and many persons seem to forget this fact when they expect an attractive showing of bloom from a severely trimmed lilac hedge. On occasion, branches bearing flower buds may be deliberately sacrificed in order that those remaining may have a better chance to develop.

Nipping Shoots to Stimulate Free Branching and High Colour

With some kinds of shrubs, such as redtwig dogwood, which are grown for the effect of their twigs in winter, the brightest colour is seen in the young twigs. But the desired response from severe dormant pruning is not likely to be fully obtained unless the heavy pruning is followed in summer by pinching out the tips of the strong growths to stimulate free branching. This practice should not be done late in the season, as an increased amount of killing back may result in kinds which are on the borderline of hardiness.

Very Early Blooming Shrubs

Very early blooming shrubs, e.g., forsythia and lilac, usually cannot be severely pruned while dormant without seriously limiting the flowers produced the next spring. But it does not necessarily follow that pruning shrubs of this class is prohibited in winter. Removal of the old worn-out wood or the correction of any irregularity of growth can be better done at this time, bearing in mind that too little pruning is preferable to too much.

Forsythia and other very early-blooming shrubs sometimes are pruned when dormant for wood which is brought indoors to bloom for a decorative effect. Such cutting, however, usually harms the bushes as it is the desired terminals that are usually cut, which give the shrub its spring show.

Cutting the flowers with long stems for indoor use serves, in part, the same purpose as pruning and, in some cases, e.g., lilac, is an important means of preventing the plants from increasing too rapidly in height, but it should not be overdone. When cutting lilac blooms for display, an eye to pruning should govern which branches to cut.

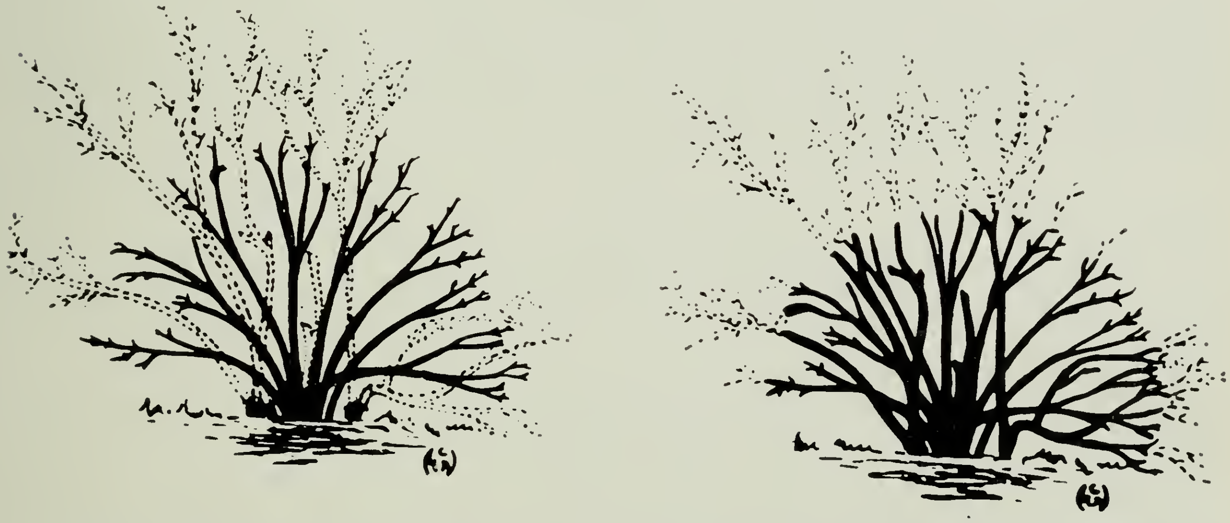


Fig. 15—Correct (left) and incorrect (right) methods of pruning many shrubs.

Pruning Shrubs for Shape

Some persons like very neat, formal bushes; others prefer the natural habit. Shaping shrubs to conform to a formal outline requires close and frequent shearing, which eliminates many flower buds. On the other hand, a type of pruning which emphasizes the natural shape need not remove an excessive number of flower buds but, by removing the old and weak branches, encourages new growth with an abundance of flowers on long, graceful sprays, and is therefore to be encouraged. It is possible with shrubs such as viburnum, Japanese quince, and barberry to restrict the plant by occasional pruning without harm to its bloom propensities, whereas to attempt to keep a tall mockorange or highbush cranberry to a 4-foot level would prevent it from ever blooming naturally.

Pruning Shrubs to Develop a Compact Twiggy Habit

Removal of the tips of growing shoots stimulates lower, latent buds into growth, thus promoting a compact, twiggy habit. Light heading back of shoots of the preceding year, when the plant is dormant, serves a similar purpose.

Use is made of this principle in shearing hedges and in trimming plants to symmetrical outlines in formal gardening. Deciduous hedges, such as those of privet, are usually trimmed several times during the growing season, though the shearing may be more frequent if an extra neat, close habit is required. Except in hedges, shearing should be practised only when it is desired to produce plants with special definite outlines.

Renovation of Neglected Shrubs

Perhaps the simplest way of handling badly neglected shrubs is to cut them back severely, sometimes removing all the top at the crown, but this will leave them unattractive for at least a year or two. A better way is to thin out a third to a half of the oldest stems at the ground in successive years. Eventually all the old wood will have been replaced with young, vigorous wood, in species where this procedure is feasible. Otherwise, as suggested earlier, such shrubs may require the planting of lower-growing plants in front of them.

The old wood of rugosa roses can be removed to advantage as soon as the hips become unattractive. It is wise to remove the 3-year-old canes each spring, especially if new canes come from the ground every year. If a strong side shoot is produced from an old cane, it may be best to remove only the part above the side shoot. Such treatment keeps the bush from becoming full of old wood that is of little value for flowering.

Certain shrubs, e.g., rose of Sharon, are usually injured in appearance if there is any attempt at a general renewal. They normally grow with two or three trunklike stems from the ground, and the top cannot be headed back without destroying the form. Usually all that can be done advantageously with such plants is to thin out the branches and moderately head back the outside branches.

Tamarix is another shrub that requires treatment after a number of years. It is a shrub that "resents" pruning, "preferring" to go its own way. But it is of such straggly and rampant growth that it is often cut back halfway, which results in unsightly tufty growths at the cut. It is better to cut the offending branches clear to the ground line and encourage new growth from the ground up.

Pruning Tardy Blooming Shrubs

Certain shrubs sometimes develop a shy blooming habit, producing many leaves and few flowers. The lilac, an outstanding example, frequently fails to come into bloom at the age expected. Sometimes as long as 10 or 12 years elapse after planting before it blooms.

Transforming a nonflowering lilac into a flowering one can be done by checking a too vigorous growth in such a way as to transfer the energy previously expended on vegetative development into the formation of flower buds. Begin by cutting the tips from new growths soon after bloom and remove the excess suckers, if there are any, from the roots. Permitting two or three suckers to grow might not be objectionable. In 2 or 3 weeks new shoots that have grown from side buds since the previous pruning should have nearly half their length removed. This is repeated until late summer. The plants should not be allowed to suffer from drought during early fall when the flower buds for the next spring are forming.

It may be wise to further check growth just after flowering time by pushing the spade into the soil at a distance of 12 to 24 inches from the plant, depending on its size, and cutting the roots all around the plant. Here, too, conditions for growth should be favourable at the time flower buds should be forming, but not so stimulating as to cause vegetative growth instead of the formation of the desired buds.

Manure should be kept from non-blooming lilacs growing in good soil until they have developed the flowering habit. Usually it is when they are in good soil and are growing too vigorously that tardy blooming occurs. Lilacs in poor soil, if they grow at all, usually form plenty of flower buds, though the flowers and trusses may be small. More fertility will increase their quality.

Hybrids of the common lilac seldom develop this non-blooming habit. Sometimes they grow unsatisfactorily or languish and die. This is usually the result of grafting the lilac on privet and is due to too-shallow planting, which prevents the lilacs from forming roots above the graft, to the natural slowness of the variety in putting out roots of its own, or to the tenderness of rootstock.

Pruning Shrubs That Sucker From the Roots

Some shrubs, e.g., sorbaria, snowberry, and kerria, spread rapidly by a multitude of underground rootstocks. If these are left undisturbed they form a dense thicket and the flowers are inferior. The plants should be pruned by thinning out the older or weaker wood. Sometimes it is advisable to dig up and replant.

PRUNING GARDEN ROSES

There are no hard and fast rules for pruning all varieties of roses. Each plant must be considered separately and pruned according to its habit and the amount of growth it makes; thus the pruning will vary with the variety and also with the purpose for which the roses are grown. Severe pruning ultimately weakens the plants and causes them to be short lived. The young shoot depends upon the food stored in the older growth until leaves have developed to manufacture enough food material to support it. Therefore, the more wood left on the st onger growths the greater the supply of plant food available for the young shoots. Light pruning results in larger plants with more blooms.

The first step in pruning a rose bush is to cut back all the dead wood. Then cut out the weak, twiggy growths. These are usually found near the base, growing towards the centre of the bush, and are not strong enough to produce flowering stems. All crossing growths should also be removed. This should leave four or five strong stems, which may be shortened, according to their growth, to give a uniform appearance. All cuts should be made so that the top buds are on the outside of the plants. This is to ensure that the bushes will not be crowded in the centre and that each new stem will get the maximum amount of light.

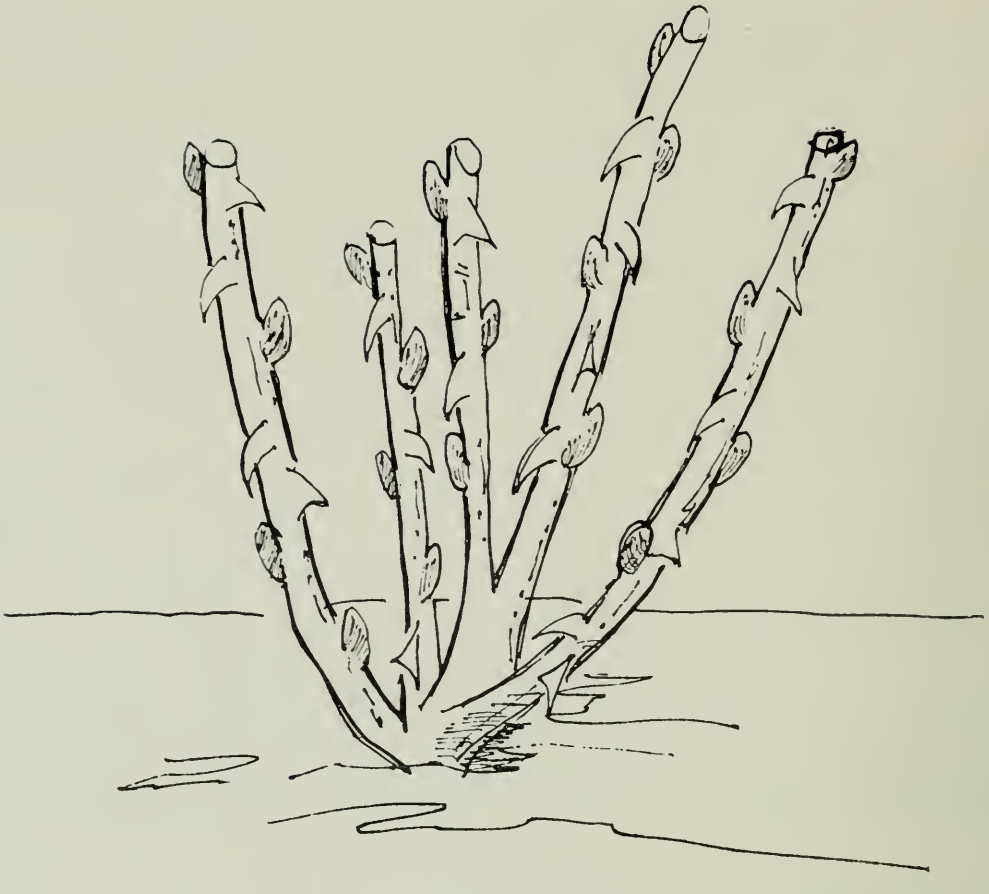


Fig. 16—In rose pruning the cuts should be made so that the top buds are directed outward.

Hybrid perpetuals may be pruned like hybrid teas, but since they are much more vigorous, more stems and larger growths may be left. Hybrid polyantha roses also require similar pruning to the hybrid teas and the pruning should be light in order to obtain as many blooms as possible. Dwarf polyantha roses should also be pruned lightly. All that is necessary, as a rule, is to remove growth which has been winterkilled, as well as weak, twiggy growth. The old flower clusters should be removed from this type in summer and fall.

PRUNING VINES

When a vine is trained to climb or cover an object it usually receives some cutting or pruning in the operation. It is when it becomes overgrown and unsightly that skillful pruning is necessary to keep things in balance. Of course, if the vine received annual attention the overgrown condition would not arise nor would any further pruning be necessary.

Pruning Newly-Planted Climbing Vines

Clematis. The pruning of climbing clematis vines varies with the species. To obtain good flowers, those species that bloom on the previous year's wood. e.g., *C. patens, C. florida, C. alpina,* and *C. macropetala,* should not be heavily pruned. The removal of dead wood or weak branches is sufficient as this type blooms profusely at the ends of the growths.

The following types bloom on the current year's growth: *C. Jackmani, C. lanuginosa, C. paniculata, C. tangutica, C. texensis,* and *C. vitalba.* With these the pruning should be done in such a way as to promote new growth. A system of staggered cuts on different shoots, some at 2½ feet, some at 1½ feet, and some at 9 inches, on different shoots, may spread the area of bloom and period of bloom.

Dutchman's Pipe, Trumpetvine, Wistaria. When plants of these vines are received from the nursery they are usually 2- or 3-year-old plants, and the stems have intertwined. It is a good plan to cut back severely and start growth anew, taking care to train each shoot in fan shape.

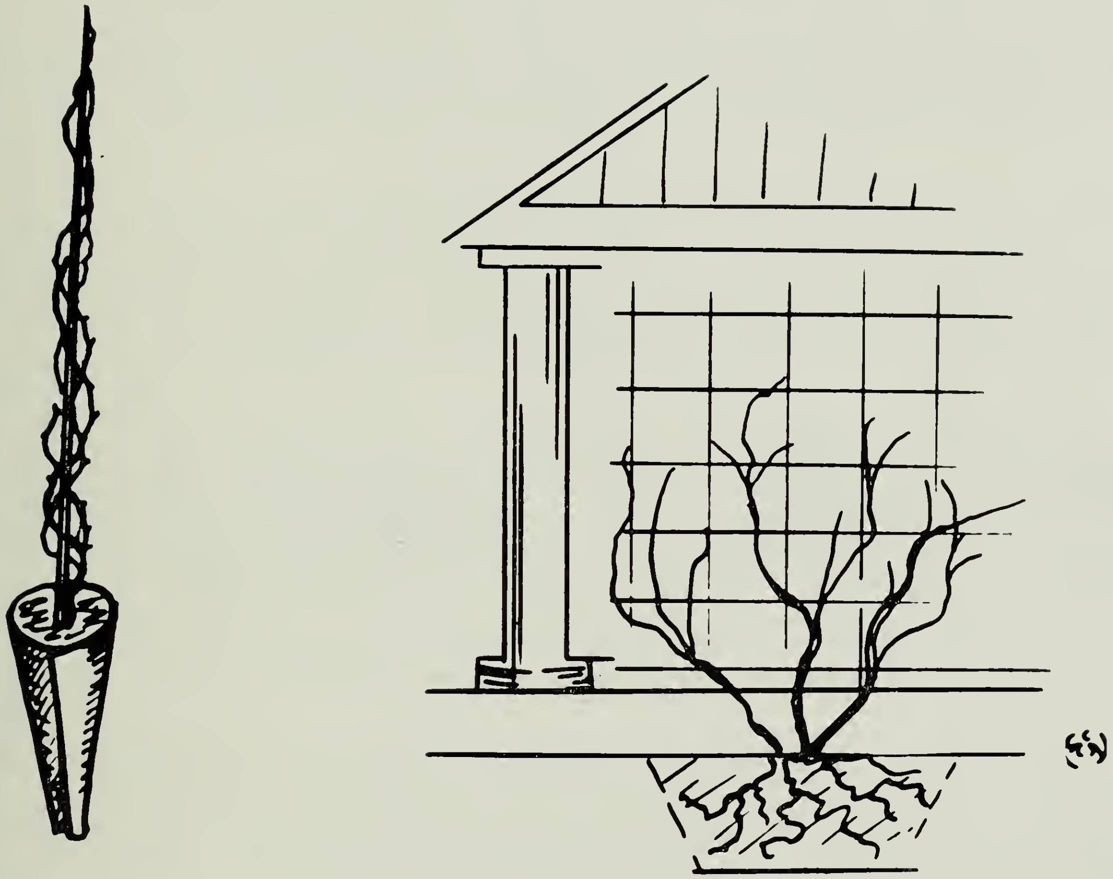


Fig. 17—Plants of Dutchman's pipe commonly are received from the nursery as 2- or 3-year-old vines, and the stems have intertwined. A good plan is to cut them back severely to start growth anew and to train them in a fan shape.

Boston Ivy, Virginia Creeper. Boston Ivy and Virginia Creeper require severe pruning at the time of planting as the old growths will not cling or twine readily and should be started anew.

Climbing Roses. Nurserymen usually ship climbing roses of 2-year growth with the tops shortened back; the number of canes varies. It is good practice to still further prune these canes to either a length of 12 inches in the fall or 6 inches in the spring, being careful to cut to an outward bud. This is severe pruning, but results will justify it.

Pruning Mature Vines

Established woody vines, like self-clinging Virginia creeper, that climb by means of rootlike "holdfasts" require little pruning. Dead or injured branches should be removed and likewise those that grow over places where they are not wanted.

When vines that climb by means of tendrils, or that twine about some support, e.g., bittersweet, tend to develop chiefly from the upper buds, leaving the base bare of foliage, the vine should be cut back severely to force it to renew its top from some of the more basal latent buds. The older stems can be cut to the ground and the top renewed from younger growths. This pruning can often be done more conveniently by removing the vine from its trellis and spreading it out on the ground. The most practical time to do this pruning is in the spring before growth begins. This treatment is well adapted to climbing roses. Cutting back can also be applied to Virginia Creeper but in this case no attempt should be made to put back any old vine "rods" as the tendrils will have lost their clinging capacity and the new growth is so rapid and so much more attractive that cutting to the ground and starting anew is more satisfactory.

TRIMMING HEDGES

Most of the beauty in any landscape is Nature's handiwork, but a well trimmed hedge (which man can claim as his own invention) catches the eye, is equally appealing, and can be made to blend with natural surroundings. A good hedge calls for much skill and precise work to attain perfection.

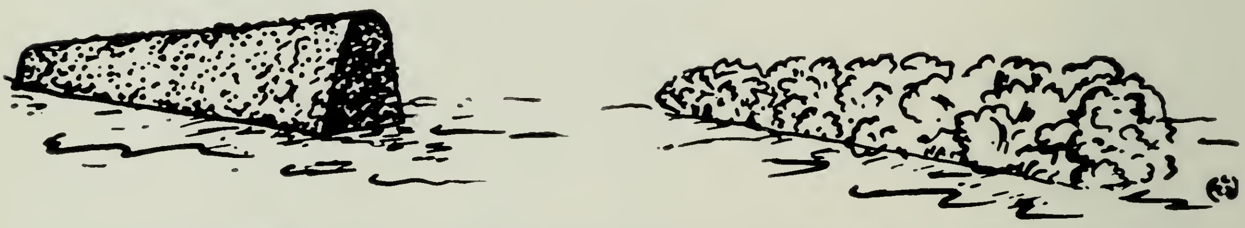


Fig. 18—Hedges can be strictly formal (left) or delightfully informal (right).

A hedge is a living fence, a boundary, a barrier, even a background. It can be made to suit many purposes. It can be, for example, strictly formal in an unerring line, with not a twig out of place, fashioned out of such material as privet or yew and kept in perfect condition by constant attention. Or, it can be delightfully informal, with bowers of arching bloom tossing this way and that, composed of "bridlewreath" spirea *(Spiraea van houttei)*, *Rosa hugonis,* Morrow honeysuckle *(Lonicera Morrowii)* or hemlock. Hemlock, though gracefully informal, still has a groomed appearance.

A hedge can be vertical in character, using common caragana *(Caragana arborescens)* or Virginal mockorange, rotund with golden mockorange, globe cedar, or mugho pine, horizontal with Japanese barberry *(Berberis Thunbergii)*, hawthorn *(Crataegus)*, Regal's privet, and winged spindle-tree *(Euonymus alata)*. Finally, kolkwitzia, forsythia, or bridalwreath spirea can provide "mile-long" cascades of colour in beautiful drooping arches.

Hedges can be made impenetrable barriers by dexterous weaving and plaiting of the growths in training, called "plashing".

They can be grown aloft or overhead by trimming the lower branches from Chinese elm, linden, or other suitable material, then training and clipping the top growth to crown a wall, or form a tall backdrop with supporting pillars, known as "pollarding".

They can be thin, and so become dividing lines between various landscape design units, or they can be thick rectangular walls of direction.

Whatever the form, hedges demand attention, maintenance, and watchfulness to keep them in good repair and appearance.

Formal Hedges

Formal hedges are a rigidly sheared type. They may be 3 feet or less to 10 feet high. Tall to medium height formal hedges are usually about 1½ to 3 feet thick. Formal hedges must be kept neatly trimmed.

Many plants are used in formal hedge work but those not conspicuously renowned for flower are most suited. Some examples are privet, barberry, cotoneaster, and ninebark in deciduous material, and cedar (arborvitae) and yew in evergreens.

Dwarf formal hedges for design work and edging may consist of dwarf viburnum and teucrium in deciduous types, and boxwood and pachistima in evergreen types.

Informal Hedges

Informal hedge plants are set in rows but are allowed to grow freely, following their natural habits, which may be irregular in individuals yet conforming to a planned regularity of line.

Suitable plants for informal hedges are such as the deciduous lilac, mock-orange, and spirea, and the evergreen spruce and fir. If an evergreen hedge is to be informal it should not be topped, so allowance must be made for the ultimate height.

Training Newly-Planted Hedges

When new plants are set out, whether they are evergreen or deciduous types, it is wise to head them back severely to promote new dense growth at the base.

With deciduous plants, e.g., privet and barberry, severe pruning can be carried out for it is this first cut that determines the density of the hedge at the base. If the plants are 2 to 3 feet high when planted and are only cut back 6 inches, the lower part of the plant will not respond to this cut. But if the plants are reduced to within 8 or 12 inches from the ground, new growth will be forced from the lowest buds and the growth of the hedge from then on can be kept dense throughout. Evergreens do not need this drastic cutting as they are slower growing and generally fill out as young plants.

Another point in early training that applies to both deciduous and evergreen types is to cut not only the sides of the hedge that show outwards, but also the sides that touch each individual shrub, thus causing much interlocking growth at commencement. This chance will not occur again and should receive this attention for the first year only.

It should also be kept in mind right from the start that the sides of the hedge should not be vertical but should be wider at the bottom so that the lower foliage will obtain some sunlight and benefit from rains; otherwise, in later years, especially with evergreens, holes and gaps will occur.

Trimming Established Hedges

Trimming an established hedge should be done at the time of its most rapid growth and in time to make the garden trim and neat when the lawns and flowers are at their best. There are cases of hedges that have been trimmed regularly for over 50 years, so no fear may arise as to possible injury from continuous shearing.

The proper selection of plant material for hedges will save much time and trouble. For instance, if a hedge of 4 or 5 feet in height is required it is better to use a shrub that will be fairly mature at that height, e.g., privet or Lemoine's mockorange, than to start out with Chinese elm, a tree that will try to grow to 40 or 50 feet and will keep you busy stopping it doing so and very likely defeat you in the end.

When to Trim

Several factors that govern when to trim are the species of hedge, rate of growth, and convenience of time for the pruner. Trimming of a long hedge should not be undertaken until time can be spared to finish it in one operation.

Most persons trim their hedges during the dormant season in late winter or early spring, often as one of the first operations when the weather becomes nice enough for the year's beginning of gardening. In many cases this is the only trimming for an informal hedge during the year. But rarely is this one cutting enough to keep a formal hedge in perfect condition. If the hedge is for neat formal work then it should be trimmed as soon as 1 inch of new growth has been made.

If hedges are pruned in early spring before growth starts, should the growth made during the summer be uneven, as often happens, the hedge is ragged and untidy looking and, if pruned in autumn, the same thing, of course, may occur when growth takes place the next spring. If only one trimming is to be done, neither of these seasons seems as good as early to late summer when the season's growth is almost, but not completely, finished. When clipped at this time a very short growth usually takes place which is just enough to cover the wounds that have been made in trimming, though, in some cases, somewhat earlier trimming may be necessary to ensure that all cuts become nicely covered.

For a perfect hedge, however, trimming at least twice a year is commonly essential; first, in late spring or early summer, and, second, about a month later. The first trimming to shape and size does much to avoid a ragged appearance and is somewhat heavier than the second. The second pruning also eliminates both bulges at the top and brush heads which may result from the earlier pruning. Additional trimmings may also be advisable for formal hedges.

The growth of evergreens usually starts a little later than in deciduous plants, hence trimming of evergreen hedges may be delayed a few weeks. But for arborvitae or cedar hedges, early spring is the best time to cut, just before growth begins, when all cuts are soon covered by the new growth. Yews may be lightly cut again in the summer. Pine or spruce hedges are only for large places, but early spring is the time to cut for best all-year effect. Cutting marks should be covered at all times by new growth. Bulges in a hedge should be cut before growth begins.

The pruning of hedges should be done annually and if they cannot be pruned at one season it is better to prune at another than to neglect it. If possible, hedges should be trimmed during a period of dull weather to avoid the burning of the freshly-cut tips by bright sunshine.

It is well to remember that summer shearing tends to check growth and weaken the plants, whereas dormant pruning is more inclined to favor wood production. Summer pruning can thus be practiced on a hedge that is thrifty, but one that shows signs of debility should be cut back in winter and left to grow comparatively freely in summer.

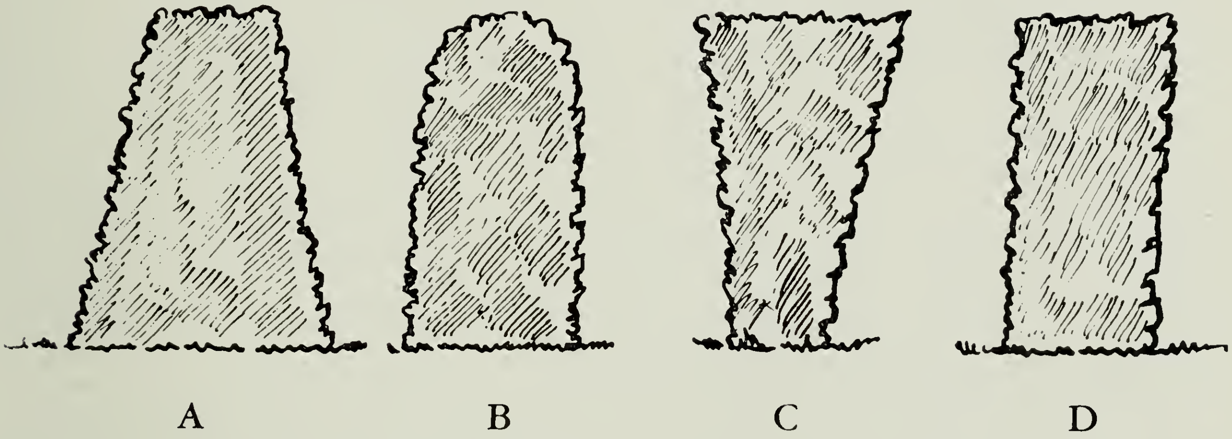


Fig. 19—The shape of the hedge should be in mind when cutting. See text.

How to Trim

It is necessary first to have the proper tools and essential that they be sharp so that young shoots are cut clean and not bruised. It often is wise to place stakes and to string tight cords or lines as guides for the correct height and evenness.

Where to start is controversial, but if the sides are clipped first, the cuttings from the top will fall clear of the hedge, and the desired height of the hedge can be better determined when the width is established.

The shape of the hedge should be kept in mind when cutting.

A hedge wider at the bottom than at the top, Fig. A. has a better chance of remaining dense right to the ground, because the lower portion is exposed to the sun. Also, in winter, less damage from snow results.

In a hedge with a cone top, Fig. B., there is likely to be still less snow damage, but this type requires more skill in trimming.

A third type of hedge, Fig. C., should be discouraged, especially in evergreens, as it is impossible to fill in the lower branches. Holes and gaps are likely to occur.

Hedges clipped vertically, Fig. D., should be chosen of vigorous material and carefully grown from their infant stage to develop thick basal branches, otherwise holes will appear.

Farm Hedges

The choice of plants for farm hedges is limited to those species which require a minimum amount of pruning, or none at all. Such plants should also be adaptable to a wide range of soil conditions and be hardy enough to withstand

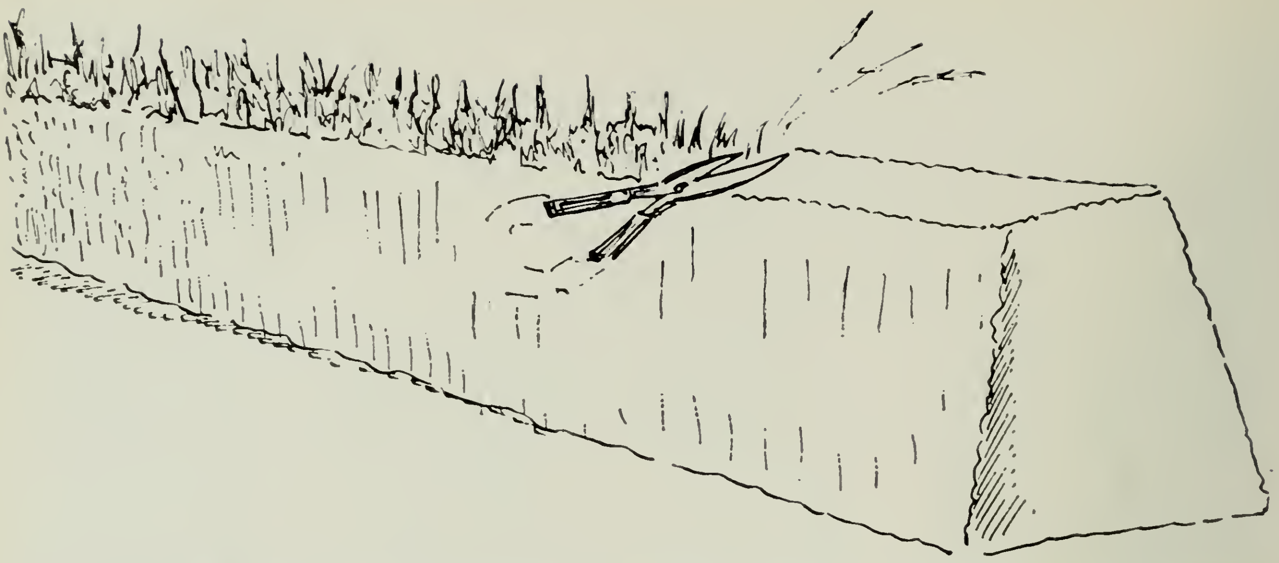


Fig. 20—If the sides are clipped first, the cuttings from the top will fall clear of the hedge.

occasional severe winters without much winter killing. Otherwise the labour cost of maintaining such hedges is prohibitive.

Locust, osage orange, and thorn hedges have been planted extensively in the past but with limited success. Rosa multiflora is presently being sold in considerable quantity for field hedging. But no great amount of information regarding its hardiness and adaptability to various soil conditions in Ontario is yet available.

In exposed localities the planting of windbreaks of coniferous trees such as cedar, spruce, and pine bestows considerable benefit. The pruning cost is negligible and is confined to removing the occasional dead branch.

SUMMING UP

A well pruned tree or shrub is a gratifying sight and should reward anyone's efforts and be a cause for thankfulness.

Intelligent pruning calls for patience, investigation, a knowledge of the "quick and the dead," and good judgment.

Pruning with thoughtfulness and observing the results, will make our gardens that much better by having well-cared-for trees and shrubs.

The argument might be advanced that pruning is not a natural act. But after a high wind the amount of dead twigs littering the ground under trees surely is a form of pruning out dead wood.

Also, every tree or shrub has a tremendous reserve stored for emergencies. If the terminal bud or branch is snapped off by natural force, latent force in sub-terminal buds immediately springs into action.

Knowledge gained by such observation can surely be used in diverting energy, and in keeping trees cleaner and healthier.

The aim of this publication is not to encourage promiscuous pruning, but rather to stimulate interest in the welfare of trees and shrubs, giving advice for the occasion when pruning is required in preference to providing the occasion for pruning.

CONTENTS

Page

Introduction 1

Basic Reasons for Pruning 1

- Pruning to Encourage Successful Planting 1
  - Balancing the Root System and Top 1
  - Pruning Balled and Burlapped (B & B) Evergreens 2
  - Pruning Fall-Planted Material 3
- Pruning to Remove Damaged or Dead Wood 3
- Pruning for Good Appearance and Beauty 4
  - Diverting Energies to Weaker Parts 4
  - Topiary Art 5
  - Twig Attractiveness 5
- Pruning for Good Floral Display 5
- Root Pruning to Overcome Shy Blooming 5
- Pruning to Control the Height and Width 6
  - Dwarfing Effect 6
  - Adjusting to the Surroundings 6
  - Low Branches on Street Trees 6
  - Evergreens 7
- Pruning to Regulate the Condition of the Plant 7
  - Thinning Out and Heading Back 8
  - Localized Influence 8
  - Renewal or Rejuvenation of the Plants 9
- Pruning to Increase the Structural Strength 9

When to Prune 10

- Intervals 10
- Pruning in Early Spring 10
- "Bleeding" 11
- Winter Injury 11

Pruning Deciduous Trees 11

- Pruning Young Deciduous Trees 11
  - Pruning at Planting Time 12
  - Growing Habits 12
- Pruning Mature Deciduous Trees 14
  - Removing Large Branches 14
  - Wound Dressings 14

Pruning Needle Evergreens 15

- Training a New Pine or Spruce Leader 15
- Shaping Mugho Pine 15
- "Plucking" Evergreens 16
- Pruning Established Evergreen Trees 16
  - Preserving Symmetry and Beauty 16
  - Shaping Soft-Foliaged Evergreens 17
  - Branch Pruning of Junipers 17
  - Covering Pruning Cuts on Evergreens 17

Page

Pruning Broad-Leaved Evergreens 18

- Ground Covers 18
- Shrubby Types 18
- Rhododendrons and Azaleas 18

Pruning Ornamental Shrubs 18

- Pruning Shrubs in the Dormant Season 19
  - Better Visibility of Framework 19
  - Shrubs that Bloom in Late Summer or Early Fall 19
- Pruning Shrubs After Bloom 19
  - Removing Seed Heads 20
  - Nipping Shoots to Stimulate Free Branching and High Colour 21
  - Very Early Blooming Shrubs 21
- Pruning Shrubs for Shape 21
- Pruning Shrubs to Develop a Compact Twiggy Habit 22
- Renovation of Neglected Shrubs 22
- Pruning Tardy Blooming Shrubs 22
- Pruning Shrubs that Sucker from the Roots 23

Pruning Garden Roses 23

Pruning Vines 24

- Pruning Newly-Planted Climbing Vines 24
  - Clematis 24
  - Dutchman's Pipe, Trumpetvine, Wistaria 25
  - Boston Ivy, Virginia Creeper 25
  - Climbing Roses 25
- Pruning Mature Vines 25

Trimming Hedges 26

- Formal Hedges 27
- Informal Hedges 27
- Training Newly-Planted Hedges 27
- Trimming Established Hedges 28
  - When to Trim 28
  - How to Trim 29
- Farm Hedges 30

Summing Up 30

A GUIDE TO THE PRODUCTION OF HIGH QUALITY MILK

•

By F. W. HAMILTON, Department of Dairying

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
STATISTICS AND PUBLICATIONS BRANCH, TORONTO, ONTARIO

BULLETIN 484

JANUARY 1952

Preface

THE object of this bulletin is to provide a handbook which may act as a guide to dairy farmers interested in producing high quality milk. An appendix is attached which includes authoritative information relative to the various problems which may confront the practical dairyman. This information is prepared by members of the staff of the Ontario Agricultural College and the Ontario Veterinary College.

TABLE OF CONTENTS

PAGE

1. INTRODUCTION 4

2. CHARACTERISTICS OF HIGH QUALITY MILK 5

3. DISCUSSION OF CONDITIONS CONTRIBUTING TO QUALITY
   - Off Flavours — Feed 6
   - Bacteria Flavours 6
   - Absorbed Flavours 6
   - Flavours of Chemical Origin 6
   - Cattle Diseases Affecting Flavour 7

4. QUALITY CONTROL
   - Personal Cleanliness 7
   - Health of Herd 7
   - Stables 8
   - Stable Yards 9
   - Flies 10
   - Clean Cows 10
   - Milk House 11
   - Filtering Milk 12

5. MILKING ROUTINE 12

6. STORING & COOLING MILK 16

7. MISCELLANEOUS DEFECTS IN MILK
   - Ropy Milk 18
   - Gassy and Yeasty Milk 18
   - Sweet Curdling 18
   - Bitter Flavour 18
   - Transportation 19

8. MARKETING MILK FROM FARMS 19

APPENDIX

1. Prevention and Treatment of Mastitis . . Dr. D. A. Barnum, O.V. College
2. Ketosis — Acetonemia in Dairy Cows . . Dr. J. Henderson, O.V. College
3. Fly Control (Horn and House Fly) . S. E. Dixon, Dept. of Entomology, O.A.C.
4. Milk House Plans and Specifications J. Pos, Dept. of Agricultural Engineering, O.A.C.
5. Cleaning of Farm Dairy Utensils and Equipment L. R. Bryant, Chemistry Dept., O.A.C.
6. Care and Maintenance of Milking Machine . . . Dairy Dept., O.A.C.
7. The Lye Method of Maintaining Milk Machine Parts in a Clean Sanitary Condition . . . . Dairy Dept., O.A.C.

QUALITY MILK PRODUCTION

Foreword

Those who gain a livelihood from the production, processing and distribution of milk and dairy products, should be vitally interested in the quality of their product. The future demand for products of the dairy industry will depend upon the quality and price of these products in relation to competing foods and substitutes.

Losses from poor quality milk rejected at the dairy plant may mean the difference between a profit or loss to the dairy farmer. To protect the producer of good milk, penalties, in the way of lower prices for inferior milk, or premiums for high quality milk are being applied or considered by those engaged in marketing of milk.

To accomplish the production of a premium article, the producer essentially must have an objective; he must in this instance know what the standards of perfection are for milk. The standard of quality is established by the consumer or his representative, which in the case of the Ontario milk consumer, is the Provincial and Municipal Departments of Health.

FIG. 1. Good milk builds healthy strong bodies.

THE CHARACTERISTICS OF HIGH QUALITY MILK

1. Clean, pleasant flavour and odour.
2. A reasonably low bacteria content.
3. Freedom from pathogenic organisms.
4. Freedom from visible foreign material.
5. At least average composition (3.5 per cent butterfat and 12.5 per cent total solids.)

There can be no finer food available to our people than milk which meets the above standard.

DISCUSSION OF CONDITIONS CONTRIBUTING TO QUALITY

So interrelated are the various factors—feed, sanitation, health—which influence quality, that it is difficult to segregate them for the purpose of discussion. Milk aseptically drawn from the healthy udder of a cow will, with the exception of the first few streams drawn, be practically free from bacteria and other forms of cell life. Therefore, the presence of bacteria cells in significant numbers indicates exposure to contamination from such sources as sediment and unclean and unsanitary surroundings and utensils, after the milk is drawn from the udder of the cow. High bacteria numbers in milk may result from heavy contamination or failure to cool the milk properly, thus permitting the multiplication of the contaminating organisms. These bacteria which gain entrance to milk and grow, break down some of the constituents of milk and produce souring or the development of unclean or even putrefactive flavours and odours in milk. Milk produced under ideal conditions has a pleasant odour and flavour and leaves no unpleasant after-taste.

The environment in which milk is produced provides ready opportunity for contamination which is detrimental to quality. The greatest care must be taken to maintain the most practicable hygienic surroundings. Fecal and dust contamination from the thighs, flanks, and under parts of the cow at milking time, dust from the stable ceilings and the stable atmosphere, improperly cleaned utensils, the clothes and person of the attendant are all possible sources of bacteria and foreign material.

Off Flavours—Feeds

Taints or flavours foreign to normal milk may be of different origin, the most commonly occurring is that imparted to the milk by feeds. The taint is generally absorbed by the blood from the feed shortly after it is consumed and is transmitted from the blood to the milk. The odoriferous nature of the feed consumed, the amount, and the proximity of time of consuming the feed to the time of milking, will influence the intensity of the flavour imparted to the milk. Milk from cows turned on fresh clover or legume pastures will have a pronounced grass flavour for a time, until the cows have lost the keenness of their appetite for the pasture, following which the milk flavour will become normal. Such feeds as turnips, rape, corn or grass silage, sweet clover, alfalfa, pasture or hay, and also weeds, such as ragweed, Frenchweed, chokecherry bushes, and other strong flavoured plants, will give to milk an objectionable flavour if consumed within two to three hours of milking. Many of these feeds may be fed after milking with no serious effect. Milk exposed to stable atmosphere permeated with strong odours will become tainted, therefore milk should be removed from the stable as soon after milking as possible.

Bacteria Flavours

Some of the most objectionable taints associated with milk are of bacterial origin. Flavours described as sour, unclean, malty, fruity, overripe, putrid or rancid are most frequently the result of improperly cleaned utensils and milk cans left in a damp condition. Only where bacteria are present in large numbers are these flavours present; therefore, they are seldom found in fresh milk which has a bacteria count acceptable for the fluid milk trade. These flavours are more prevalent in cream collected on the farm.

Absorbed Flavours

Milk fat absorbs taints readily. Milk exposed to an atmosphere permeated with strong odours, such as gasoline, some fly sprays, poorly ventilated stables, or cellars, etc., will become tainted.

Flavours of Chemical Origin

A number of off-flavours result from a breaking down of some of the constituents of milk and cannot therefore be attributed entirely to the action of bacteria. Most common among these are oxidized or cardboard flavour, rancid, and salty. These flavours are not usually associated with high bacteria counts and frequently are present in milk of otherwise fine quality. Milk normally contains an enzyme known as lipase, which under certain conditions will hydrolize the fat and result in rancid flavour.

The milk from individual cows and herds varies in its susceptibility to oxidized flavour. Why this is the case is not entirely understood. However, it is suggested that this phenomenon may be associated with variations in the fat composition resulting from the rations. Winter milk is more susceptible than milk produced on pasture. Contamination with copper and iron and exposure to light are conditions favouring the development of this flavour. Milk of low bacteria content is frequently more susceptible to oxidized flavour than milk of lower quality.

Cattle Diseases Affecting the Flavour of the Milk

Mastitis—an infection causing an increase in the salt content of milk accompanied by a reduction in the sugar, thus imparting to the milk an unclean salty type of flavour.

Acetonemia—a condition resulting in an increase of ketone bodies in the blood, producing a flavour in the milk very frequently mistaken for feed flavour. This condition is most prevalent in high-producing cows during late winter and spring.

The milk from cows suffering from the above or other abnormal conditions should be retained on the farm for feeding livestock. The mixing of abnormal milks with the market supply means lower consumption of milk and milk products, and heavy losses to the producer through rejected milk.

QUALITY CONTROL

The key to quality control lies in:

1. Personal cleanliness of the dairyman.
2. Healthy herds.
3. Clean, well-lighted stables.
4. Clean cows and utensils.
5. Proper cooling.

Personal Cleanliness

Since milk is a human food, the same degree of cleanliness should be exercised in the production and handling of it as we expect of the housewife when preparing meals. Those handling the milk must be in good health, free from communicable diseases, and suitably clothed. While it is not an essential to wear white overalls and jackets, it is important that a clean cotton coat or smock be kept and worn for milking only. Sweaters and woollen shirts collect dust and cow hairs which later may fall in the milk pail or can. Prior to preparing the milking utensils the milker should wash his hands thoroughly and put on the clean smock.

In the production of a high quality milk the human factor is the most important.

Healthy Herd

A healthy herd is a more profitable herd; disease reduces production and increases the rate of replacements, as well as endangering the health of the herd-owner's family and consumers of milk. Dairy cattle disease-control programs are in operation throughout the Province of Ontario, and the wise dairyman will keep in touch with the various control measures available. The tuberculin test and blood agglutination tests for Brucellosis, provide means to detect these conditions, while mastitis control requires constant attention to avoid serious herd infection.

Milk from cows with mastitis is not fit for marketing and should be withheld until such time as the cow is completely recovered. The regular use of a strip cup to detect garget, and the early detection of udder inflammation will permit prompt treatment with the recommended drugs. Treatment during the early stages of mastitis usually brings recovery of

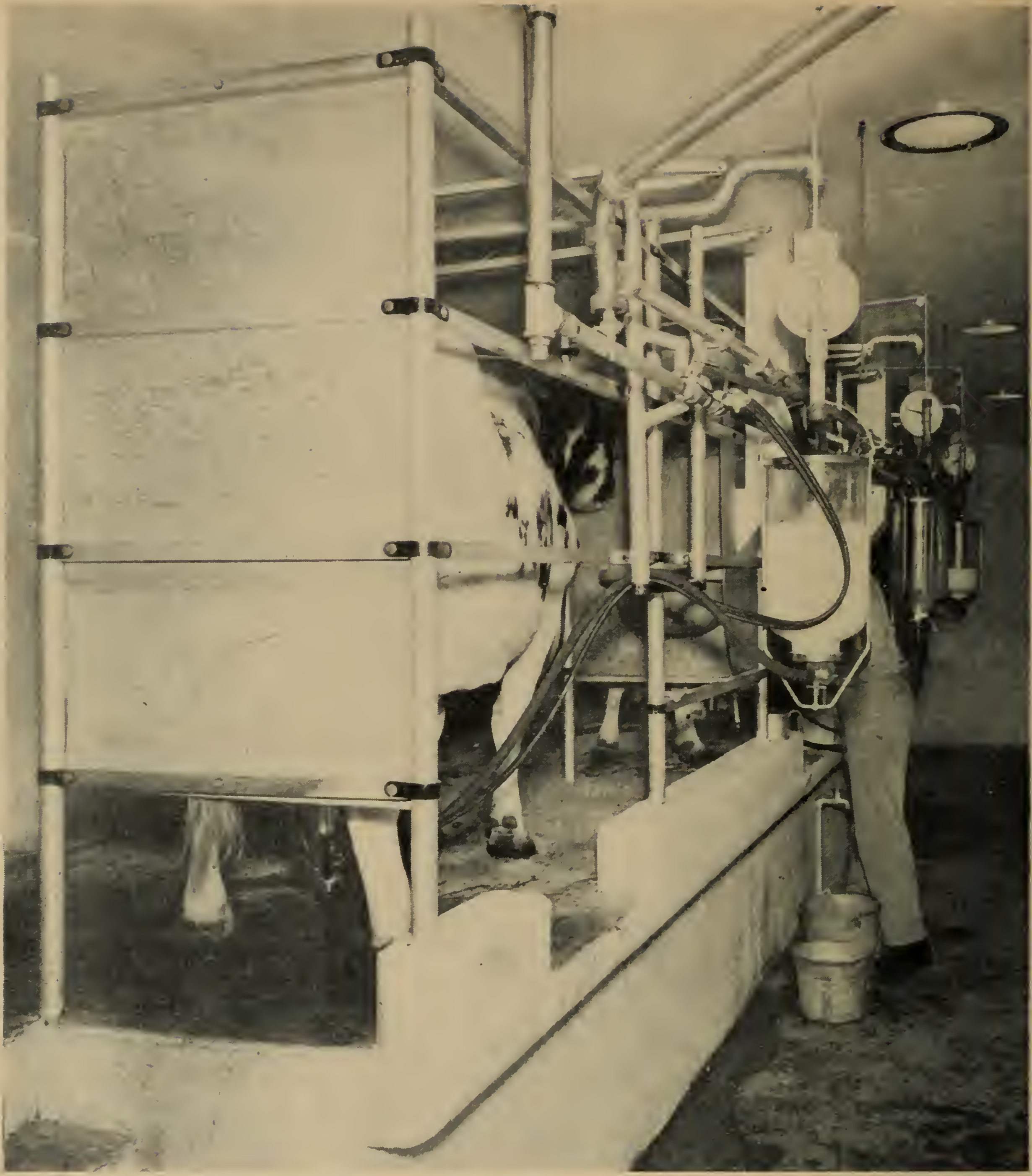


FIG. 2. Milking parlor at the Ontario Agricultural College.

the animal. See appendix, page (22). The milk should not be used for human food until 72 hours after treatment is completed.

A healthy, thrifty herd is an important step toward the production of good milk.

Stables

Dairy cattle stables need not be elaborate or expensive, yet certain basic conditions are essential:

(a) adequate lighting
(b) moisture-proof floors, with adequate drainage
(c) ventilation to provide a dry, healthy atmosphere free from odours
(d) smooth walls and tight ceiling.

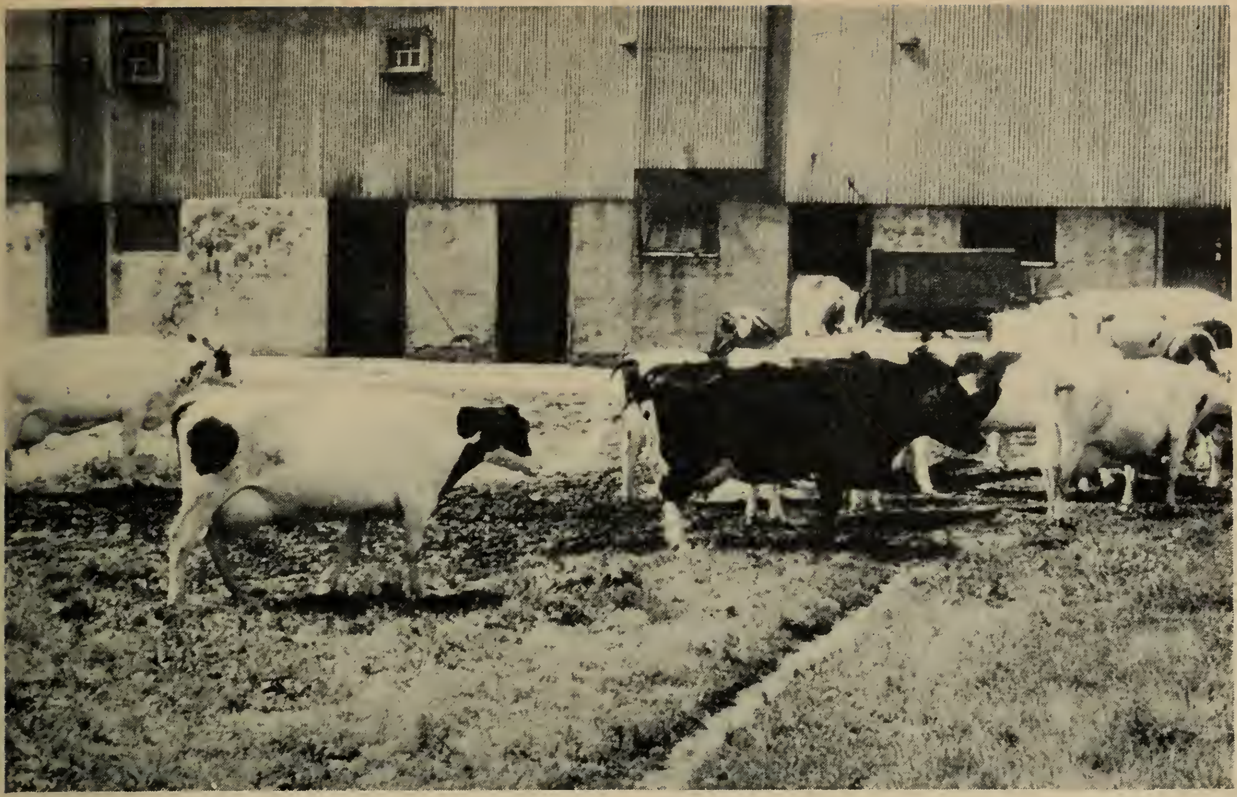


FIG. 3. Clean yard with cement walk in front of stables.

From three to four square feet of glass per cow so placed to avoid dark areas or corners will provide sufficient light to create pleasant working conditions and assure attention to accumulation of cobwebs, dust, etc.

Cement possibly provides the most sanitary and economical material for the construction of floors, stands, and gutters in the conventional style of stabling.

Pen stabling and milking parlors are gaining in favour. The milking parlor makes it possible to maintain excellent sanitary conditions, including tight walls, ceiling and good ventilation at milking time at a minimum cost. A number of commercial installations are now available, which deliver the milk direct from the cow to the milk room, eliminating exposure to stable contamination. Loafing pens must be well drained, light, roomy, with ample straw available for bedding so that the cows may be maintained clean and thrifty. While milk sanitarians in some instances object to the principle of the litter in loafing pens being permitted to accumulate and be cleaned out periodically, however, actual practice points to good results when ample bedding is available.

Stables should be kept clean by sweeping the ceiling and walls frequently enough to keep them free of cobwebs and dust. They should be painted or whitewashed annually. Floors and gutters should be swept clean, and stable phosphate or hydrated lime spread on the floors and gutters.

Stable Yards

Manure should be removed from the yards daily. Open manure piles or pits provide a breeding place for flies, as well as contribute to the accumulation of dirt on the animals, particularly during wet weather. Yards should be well drained and preferably surfaced with cement, quarry chips or gravel.

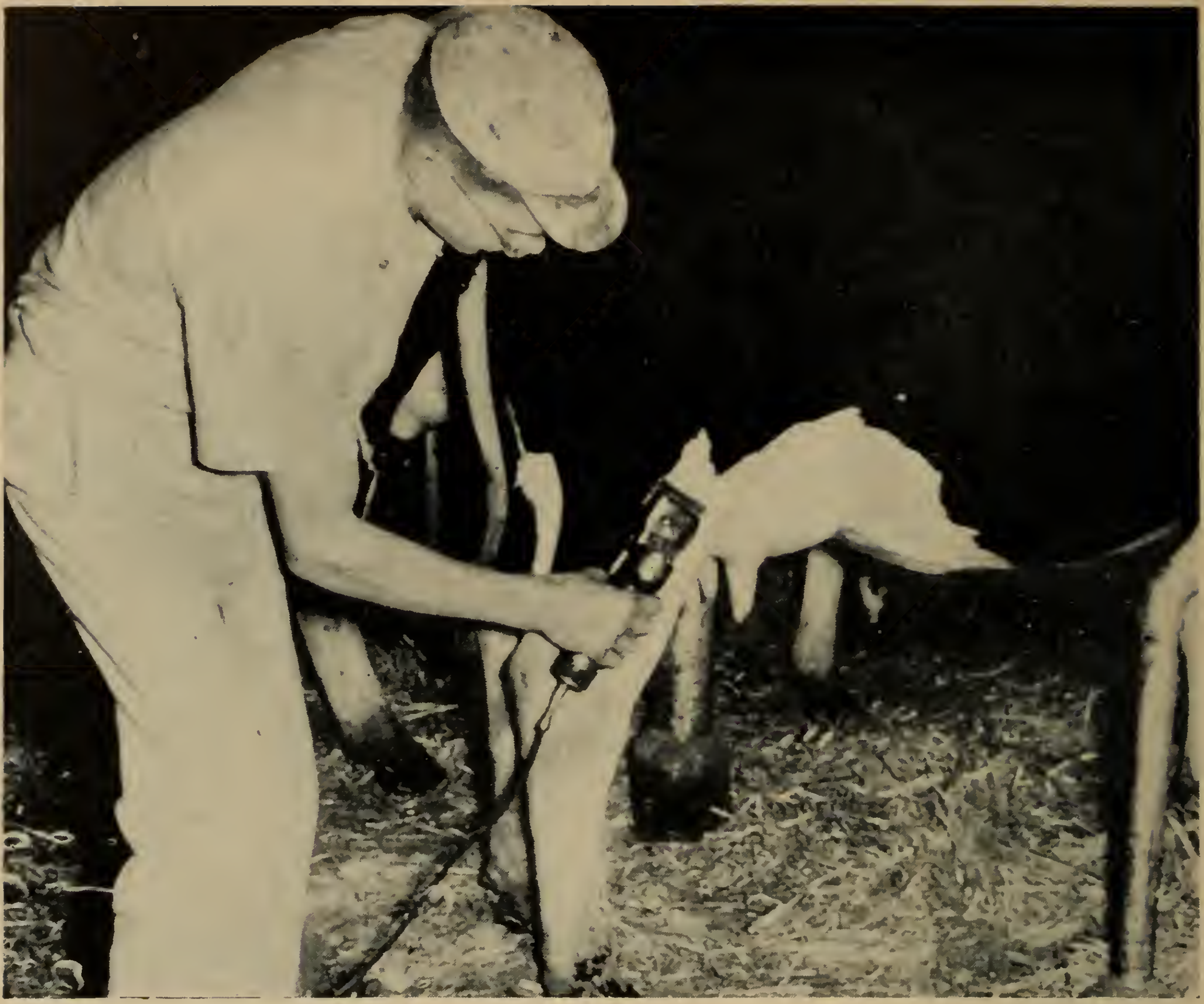


FIG. 4. Clipping cows to remove long hair from thighs.

If not practical to cement the entire yard, a ten foot cement walk in front of the stable entrance will provide protection for the cows entering the stable.

Flies

The life habits of the house and cattle horn fly are such that they are always a potential source of harmful contamination. The breeding place of flies is commonly in manure pits and filth, and in their movements from place to place contamination is carried from these sources.

Flies are a source of annoyance to the cows and the herdsman, and frequently are the cause of dust and dirt inadvertently falling into the milk pail, or the knocking of teat cups of the milking machine to the stable floor by the efforts of the cow to remove flies.

Fly control has been greatly aided by the use of modern chemicals. The control of flies will mean cleaner milk and more milk (see appendix, page 26, Fly Control).

Clean Cows

Clip the fine hair from the udder, flanks and belly of the cow. The first clipping should be done immediately prior to stabling in the fall of the year and repeated as frequently throughout the winter as necessary to keep the hair, in the area described above, short. Plenty of clean bedding (straw or shavings) will aid in keeping cows clean and comfortable.

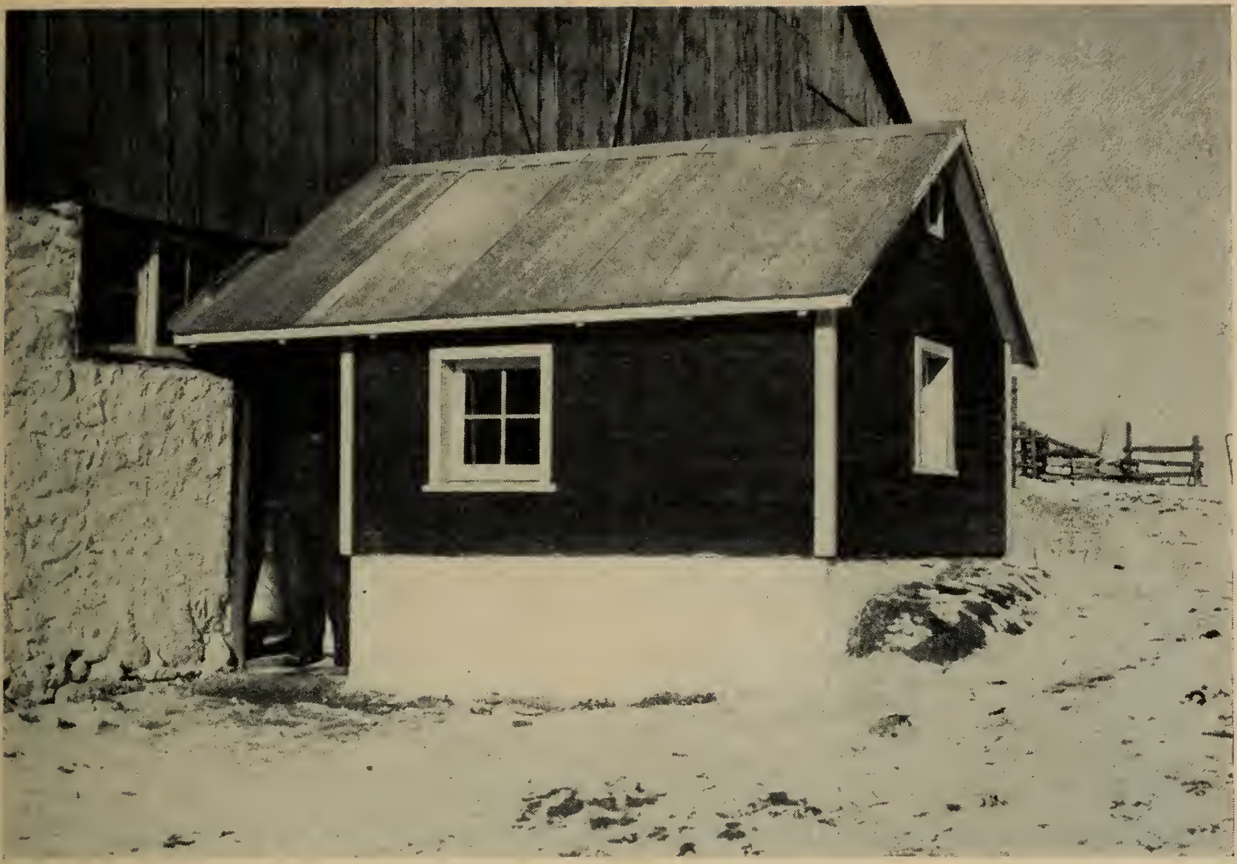


FIG. 5. Milk house constructed from plan in appendix.

Daily grooming during the winter months when cattle are stabled not only will keep the coat of the cow free from dandruff, dust and loose hairs, but help to keep the herd in a thrifty condition which will increase production and add greatly to the pride which the dairyman will have in his herd.

The Milk House

A special room or building set aside for the cooling and storing of milk as well as the washing of the milk utensils is an essential to the production of good milk.

Regulating bodies set out definite requirements relating to the milk house location and general plan. The following requirements are embodied in most of the plans formulated by health authorities:

1. The milk house should be located close to or adjoining the stable for convenient use.
2. The location should provide good drainage and be as far from stable yard or other undesirable suroundings as possible.
3. The milk house may adjoin the stable but not open directly into the stable.
4. It should be constructed of material which is resistant to moisture and provide easy cleaning.
5. All windows, doors or other openings should be screened to keep the milk house free from flies.
6. The milk house must be adequately equipped to cool and store milk, and to wash, sterilize and store equipment.

The equipment should include a cooling tank, wash sink, equipment for heating water, racks for storing cans, milk pails, etc., and a cupboard for storing cleaners, sterilizers, brushes, filter pads, etc.

With a good plan any handy dairyman may construct a serviceable, well-constructed milk house which will meet these requirements (see plans and specifications in appendix).

Filtering Milk

Because of the character of the conditions surrounding the production of milk, filtering of the milk is an essential precaution to avoid particles of dirt, cow hairs and bedding which may have accidently entered the milk, remaining there during the storage period prior to delivery of the milk to the processing plant. However, filtering must not be practised as a means of overcoming careless unsanitary practice. The harmful bacteria associated with the above material are washed through the finest of milk filters and only the coarse, relatively harmless material is retained on the filter.

Milk must be produced and handled so that it is clean if it is to have the fine quality of a good food. Unclean milk filtered clean, is a poor substitute.

Use single service filters — a filter pad at least ½″ in diameter greater than the diameter of the metal filter. Filter pads are purchased in a cardboard container and should not be unnecessarily exposed prior to use. Provide a cupboard in the milkhouse for the storage of filters.

MILKING ROUTINE

A well organized routine for milking will assure efficiency from the standpoint of economy of labour, materials and quality of the product produced.

The milker should be continuously reminded that milk is being produced for human consumption. The first step toward the production of a good safe milk is to wash the hands thoroughly and put on a clean jacket or shirt. If hand milking is practised, rinse the milk pails, strainer and cans with a warm sterilizing solution (chlorine), following which this same solution may be used to wash the flanks and udders of the cow. The milker should at all times avoid creating a dust or any condition which will cause milk contamination.

The dairyman may find it necessary to make minor adjustments to the following routine to suit his individual circumstances.

Rules for milking:

1. Milk with clean hands. Do not wet teats or hands with milk.
2. Avoid a dust being created during milking. Do not have feed or bedding handled just prior to or at milking time.
3. Keep milk stools clean and paint and wash them at frequent intervals.
4. Small top milk pails reduce contamination and are to be recommended for hand milking.
5. Do not leave milk exposed in open pails within the stable longer than is absolutely necessary. Remove milk to the milk house and strain into cans.

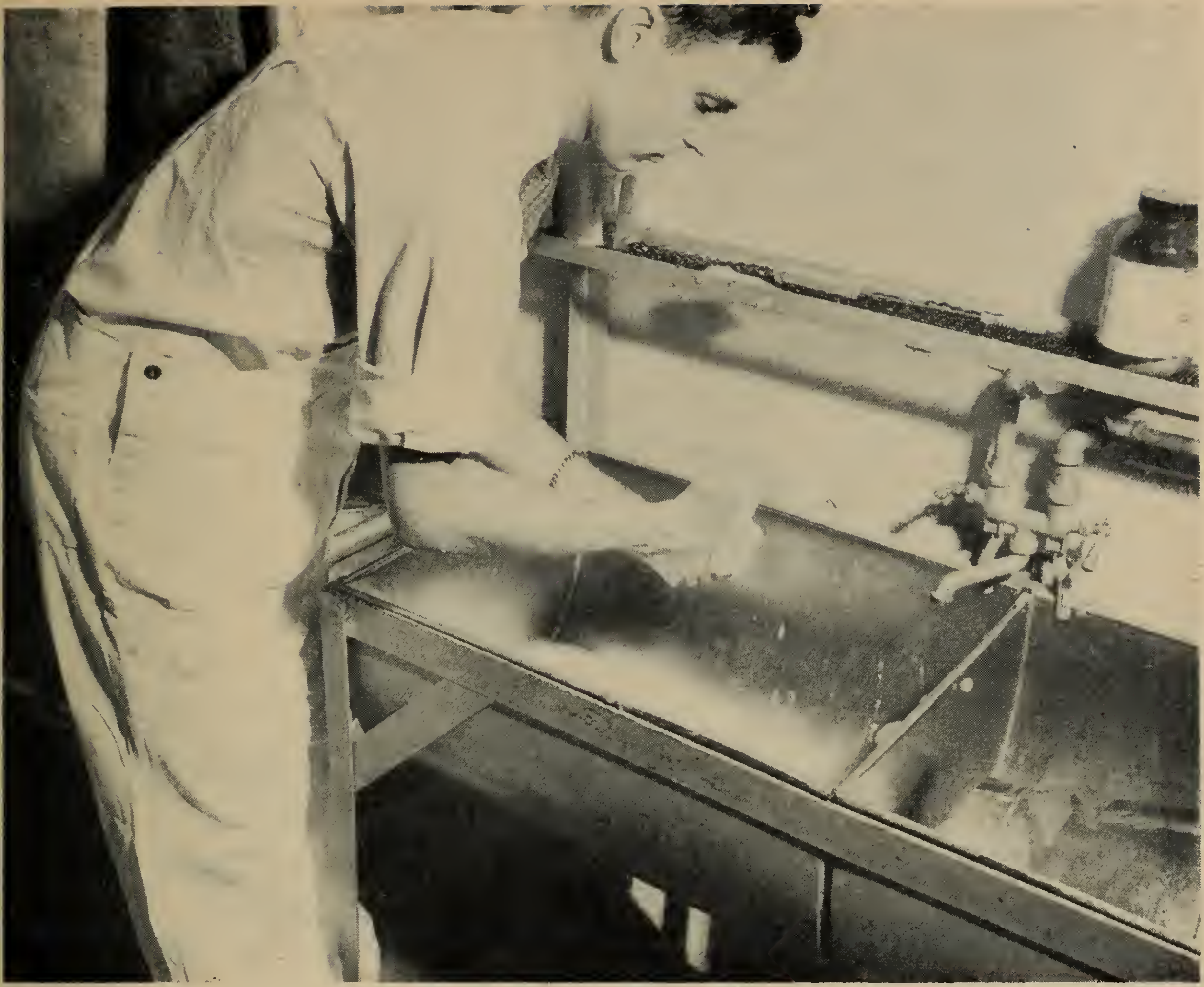


FIG. 6. Washing hands before commencing to milk.

6. Use single service strainers. Strainer cloths are difficult to maintain in a sanitary condition.
7. Place covers on cans and place in the cooling tank immediately after filling.

Machine Milking Routine commencing with preparation of machine for milking:

1. Have at least one pail (2½ gallons) of hot water (160° F.) available for rinsing.
2. Add sufficient chlorine sterilizer to obtain the concentration recommended by the supplier. Some of the newer quaternary ammonium compounds may be used in place of chlorine if preferred.
3. Assemble machines and draw the warm sterilizing solution through each unit. Before pouring out the solution give the milker pails a rotary shake to assure contact of the sterilizing solution with all parts of the pail and lid.
4. Pour half of the sterilizing solution into a pail to be used for washing the cows' udders, the remainder to be used to rinse the milk strainer and cans.
5. Wash the udders of the cows with the warm sterilizing solution within two minutes previous to putting the machine on.

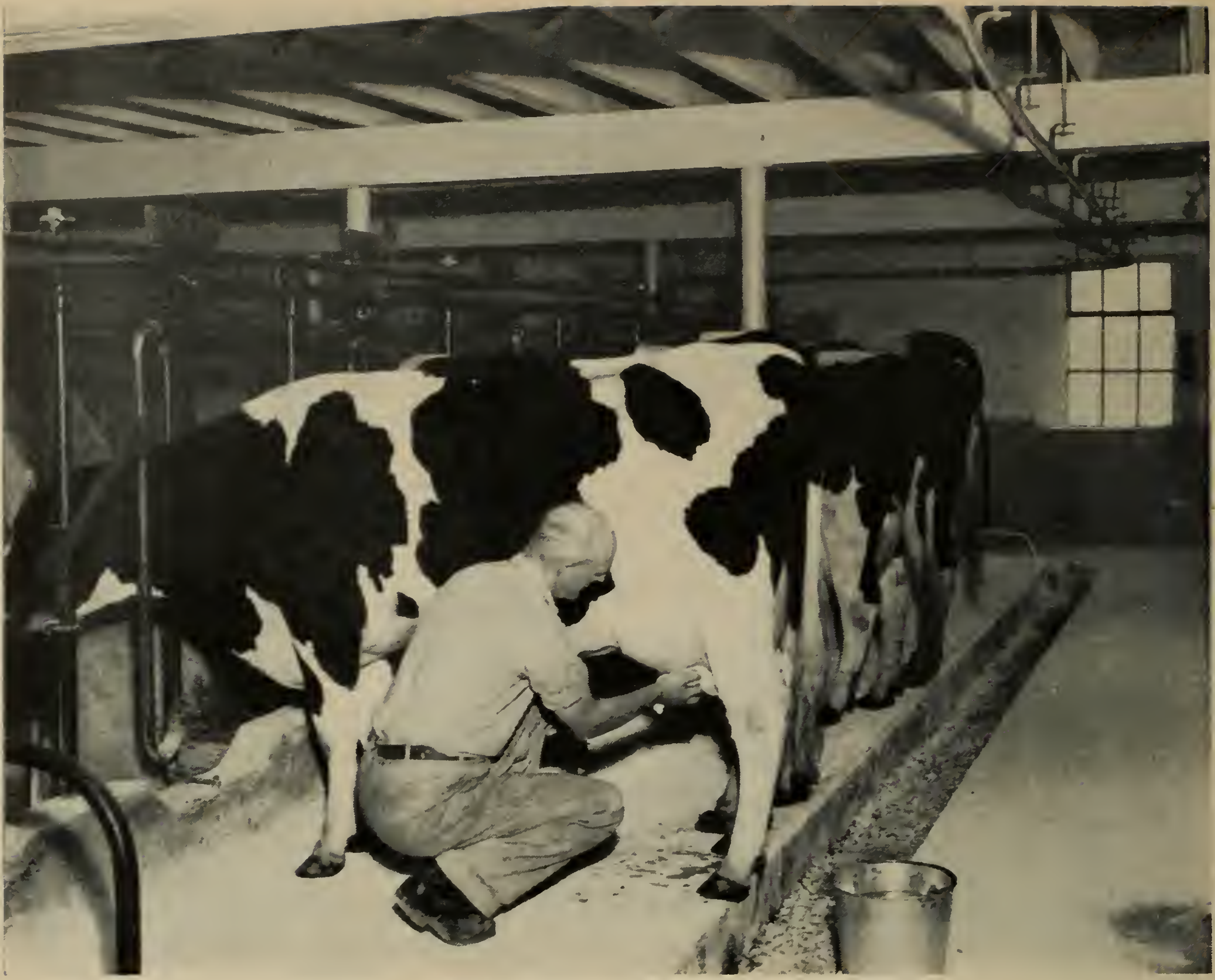


FIG. 7. Washing the udder prior to milking.

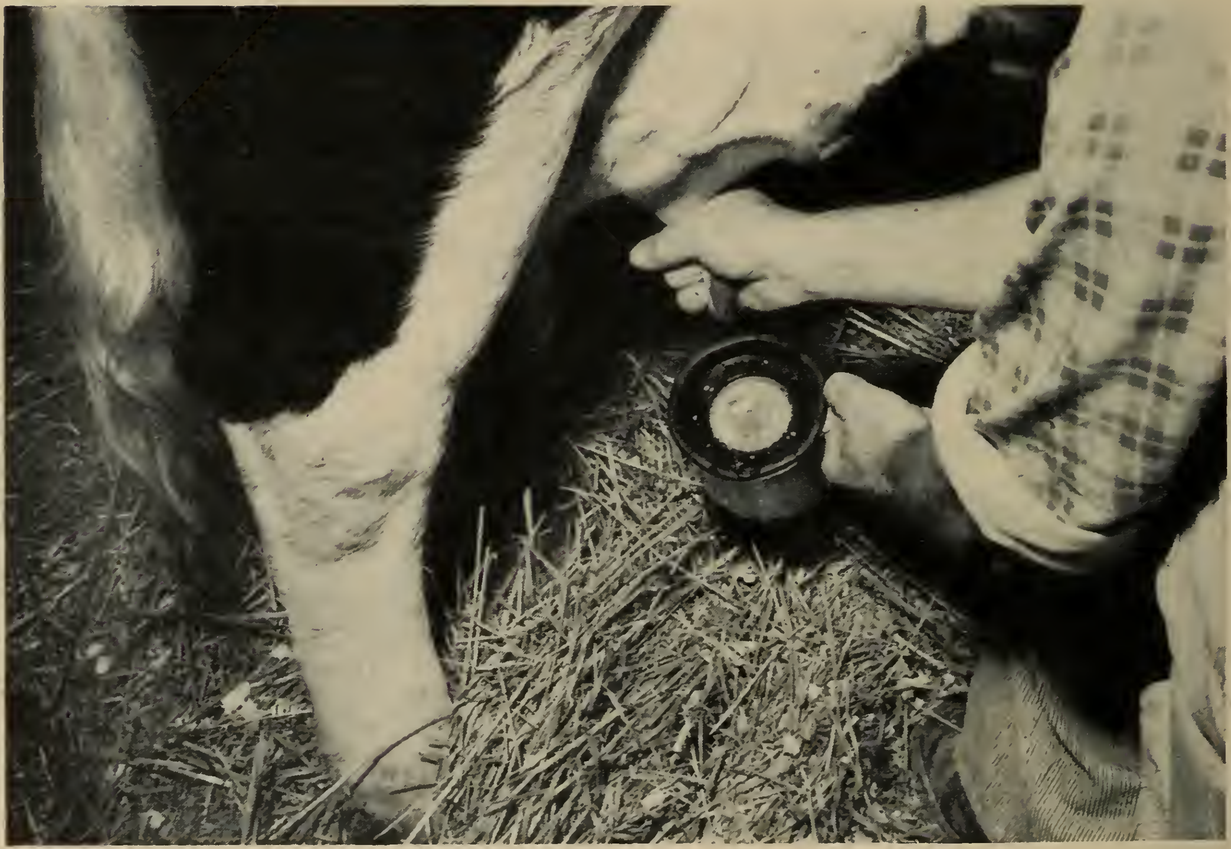


FIG. 8. Using the strip cup.

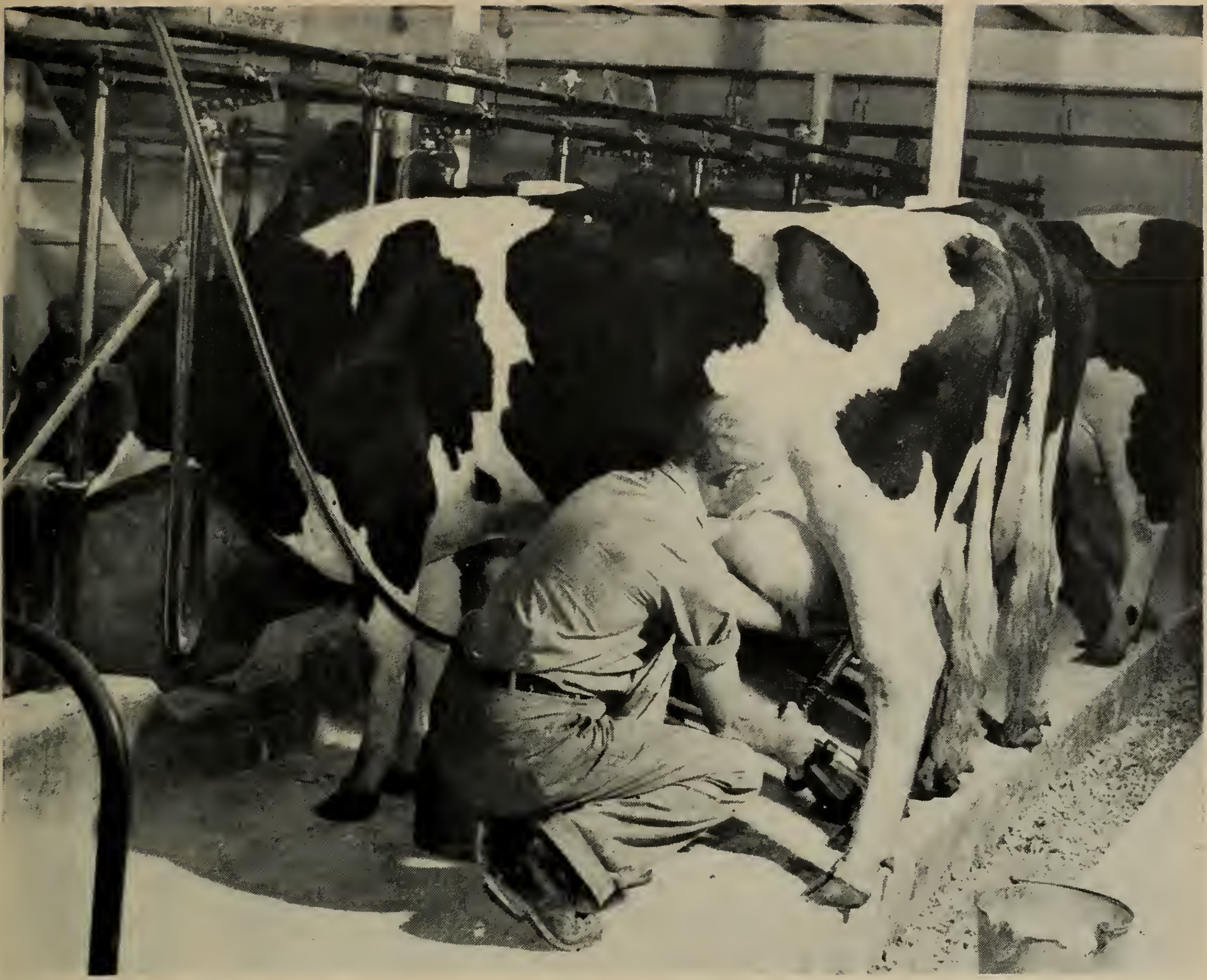


FIG. 9. Holding the teat cups to prevent accidental suction of floor dust.

6. Massage the udder and draw a few streams of milk from each quarter into a strip cup. The purpose is to stimulate milk flow and provide a check for udder infection. Frequently the first few streams of milk drawn from the teat are heavily contaminated with bacteria; therefore, this practice has the additional value of reducing bacterial contamination.

7. When putting the teat cups in place, so grip the milker claw as to eliminate the possibility of the teat cups tipping sidewise in the hand and allowing dirt from the floor to be sucked into the milker pail.

8. Upon completion of milking, draw a pailful of cold or luke warm water through the milking unit by intermittently immersing the teat cups in the water. Hot water at this stage of cleaning causes milk to stick to surface of equipment.

9. If long tube milkers are used, place teat cup assembly on solution rack (see page 37). Short tube milker rubbers may be washed with other utensils and stored dry or placed in the same 0.5 per cent lye solution as used in the solution rack.

10. Disassemble machine and wash pails, lids, and strainers in the wash sink using a cleanser suitable to the hardness of the water (see appendix, page 33, washing dairy utensils), with a brush or steel sponge, not a cloth. Rinse all utensils with hot water.

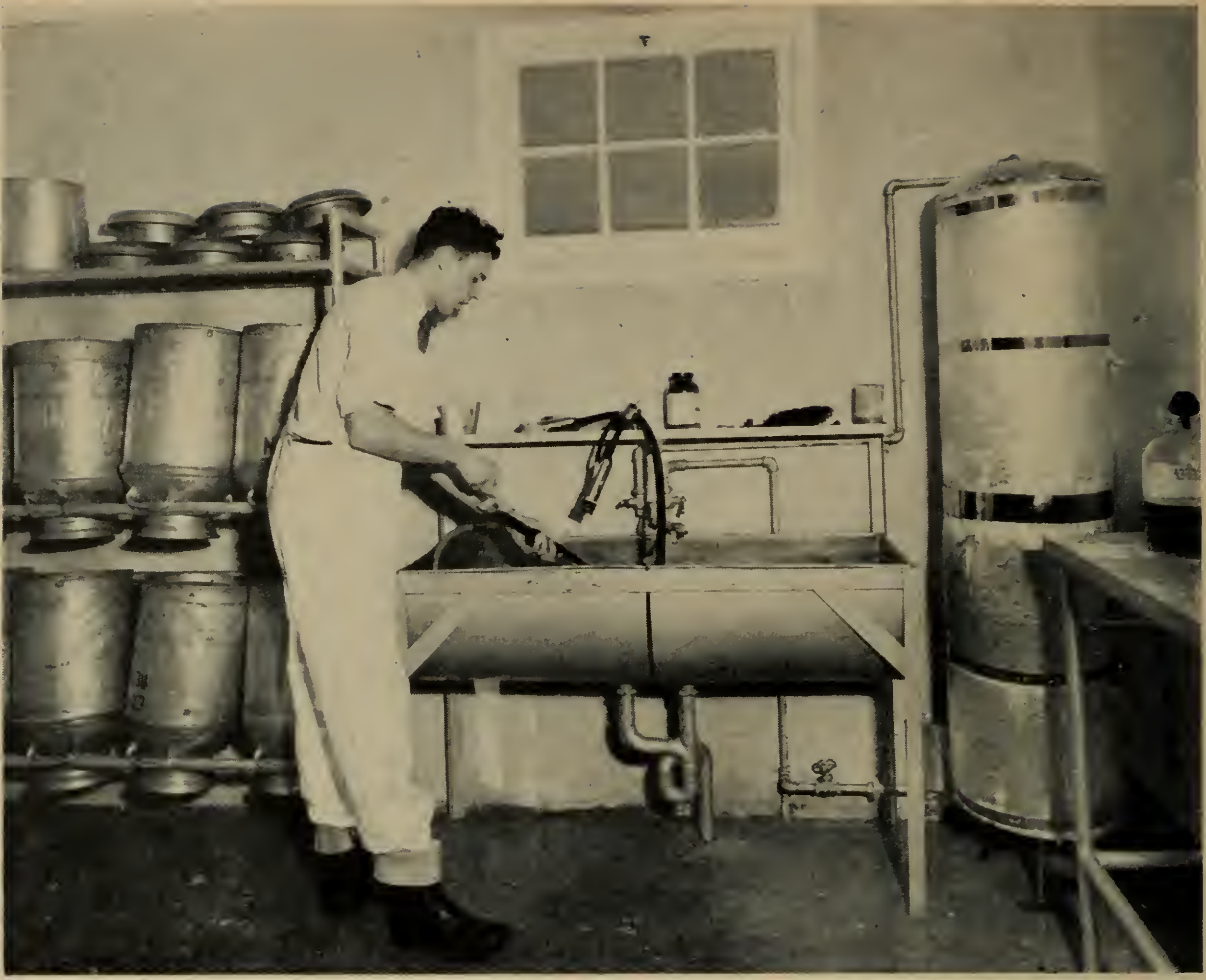


FIG. 10. A convenient milk room with racks for storing utensils.

11. Invert pails, cans, strainers, etc., on racks in the milk house.
12. Clean up sinks, wash pails, and floors.
13. Take teat cup assembly apart and wash all parts once each week.

STORING AND COOLING MILK

A good product carefully produced is worthy of a good container. Use only milk cans which are well constructed; there should be no open seams at the junction of the bottom and sides or at the shoulders; they must be free from rust and corrosion. Pressed steel cans are now available which lessen the possibility of open seams. Aluminum cans are widely used in Europe and appear to be a satisfactory milk container.

As soon as a can is filled, the lid should be put in place and the can immersed in the cooling tank. Where conditions in the milk house provide freedom from dust, and the operator is careful to avoid contamination from his clothing or the stirring rod used, agitation at intervals will hasten the removal of the animal heat and freqently improve the flavour.

Stirring is not to be recommended on farms where there is danger of carelessness. The lids should be placed tightly on the cans and left on until delivered at the plant.

The milk should be cooled as soon as possible to below 50° F. At higher temperatures bacteria multiply very rapidly. The influence of

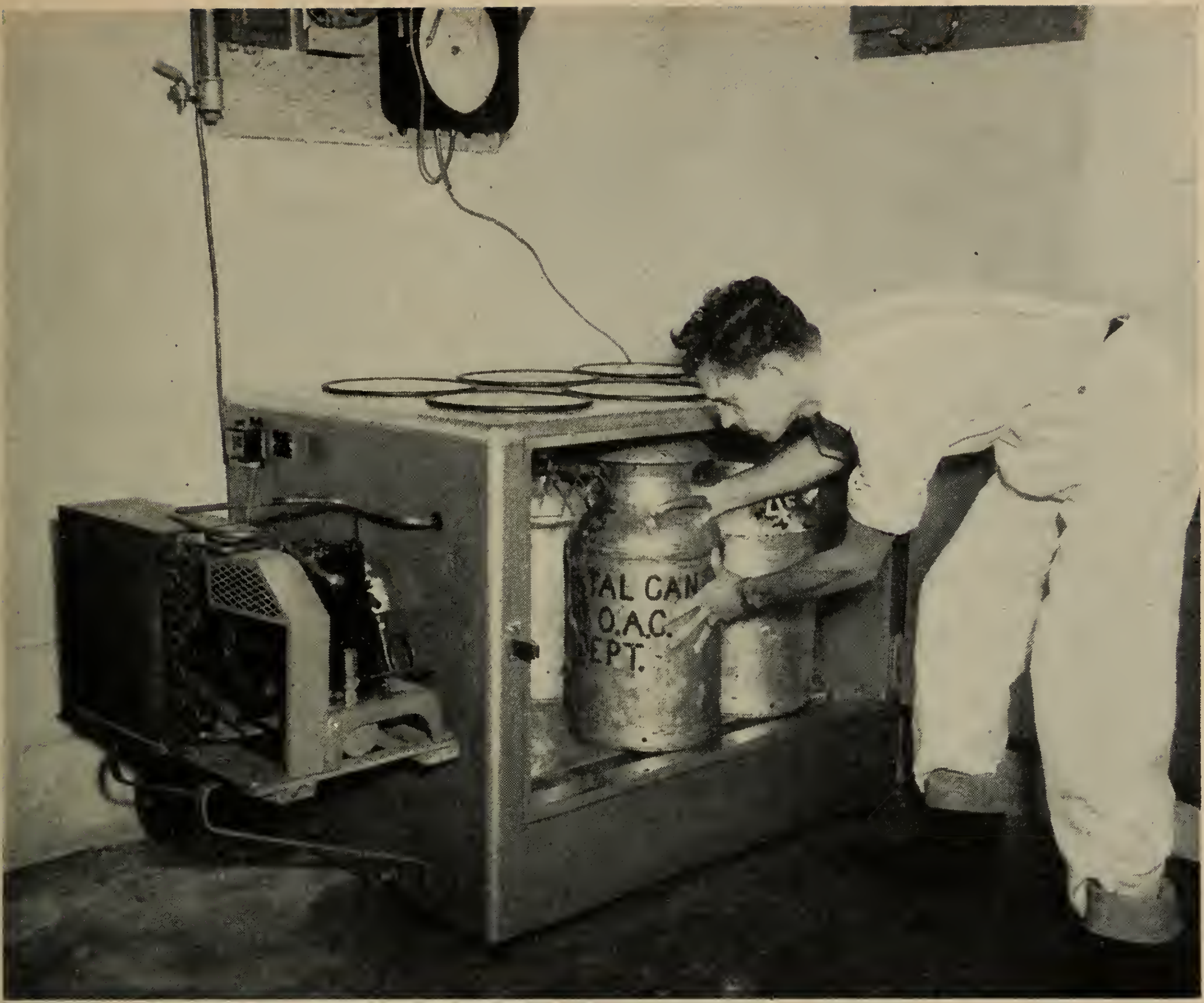


FIG. 11. Spray type of mechanical milk cooler.

temperature upon bacteria increase is illustrated in the following table, where a quantity of milk was divided into six parts and exposed to different temperatures for a period from 10 to 11 hours.

Temperature of Milk	Time Held	No. of Bacteria
32°F.	10 hrs.	3,000
50°F.	10 hrs.	11,580
60°F.	10½ hrs.	15,120
70°F.	11 hrs.	188,000
80°F.	11 hrs.	2,631,000
90°F.	11½ hrs.	4,426,000

Nebraska Bul. 133

Cooling must be looked upon as a means of preserving milk. Milk heavily contaminated as a result of unclean surroundings and careless methods cannot result in a good product regardless of how efficiently it may be cooled. Clean milk, properly cooled will arrive at the market in good condition.

The method of cooling will depend upon the individual circumstances. Milk supplied to a local market may be sufficiently preserved by cooling accomplished with running water, while milk for the more distant market where the period of transit is several hours, must be cooled by ice or mechanical refrigeration which permits cooling to 45° F. or below.

If it is necessary to have milk cooled immediately after milking for transporting to market, a surface-circulating cooler may be used. If chilled water or brine is used, the cooling is efficient. However, the surface cooler adds to the work of washing and cleaning and may easily become a source of serious contamination if not properly cleaned or if exposed to dust.

MISCELLANEOUS DEFECTS IN MILK

Ropy Milk

There are several types of bacteria which produce a slimy condition in milk. These bacteria produce a gelatinous substance around the cell which imparts to milk this ropy characteristic. Frequently the milk when poured will form long strings from a few inches to a foot in length. These organisms are not harmful, but because of their ability to survive normal cleaning practices and frequently pasteurization, they are a source of worry to the dairyman and the milk is not acceptable to the market.

The organisms causing this ropy condition are frequently found in ponds and shallow wells and become established in milk-cooling tanks and milk utensils. The control lies in rigid sanitation and preventing the milk cows from wading through ponds and swamps. Where an outbreak occurs an overall cleanup is necessary. Thoroughly scrub the milk house, using a lye solution on the floors, cooling tank, tables, etc., and wash and boil all milk pails, strainers and other utensils. Milk cans should be thoroughly cleaned both inside and out and rinsed with a chlorine solution containing 200 ppm. of available chlorine. A sample of well water, taken in a bottle which has been previously boiled, should be sent to the Bacteriology Dept., O.A.C., for bacteriological examination.

If the source of contamination is the farm well, steps should be taken to prevent surface water, following heavy rains, entering the well. Frequently a cement curb and cement platform on the well will prevent this surface contamination. Until such time as the well is eliminated as a source of contamination, all water used for rinsing or which in any way comes in contact with the milk utensils should be treated with chlorine.

Gassy and Yeasty Milk

Certain types of bacteria common to stable filth produce acids and gas which impart to milk a very undesirable flavour and aroma. Yeasts are more common in summer milk and where proper cooling is not practised, a yeasty flavour in the milk may develop. The most serious consequences of the above types of contamination and growth are observed in the products made from the milk.

Sweet Curdling

This defect is rare in the fresh milk supply; however, occasionally milk which is sweet will coagulate or curdle. This condition is caused by enzymes produced by certain organisms which have become dominant in the contaminant. Thorough cleaning and sterilizing of all milk utensils is the essential control.

Bitter Flavour

Bitter flavour is caused most frequently by the cows eating weeds or shrubs. However, milk from cows in advanced lactation or milk contaminated by some types of micro-organisms will develop a bitter flavour.

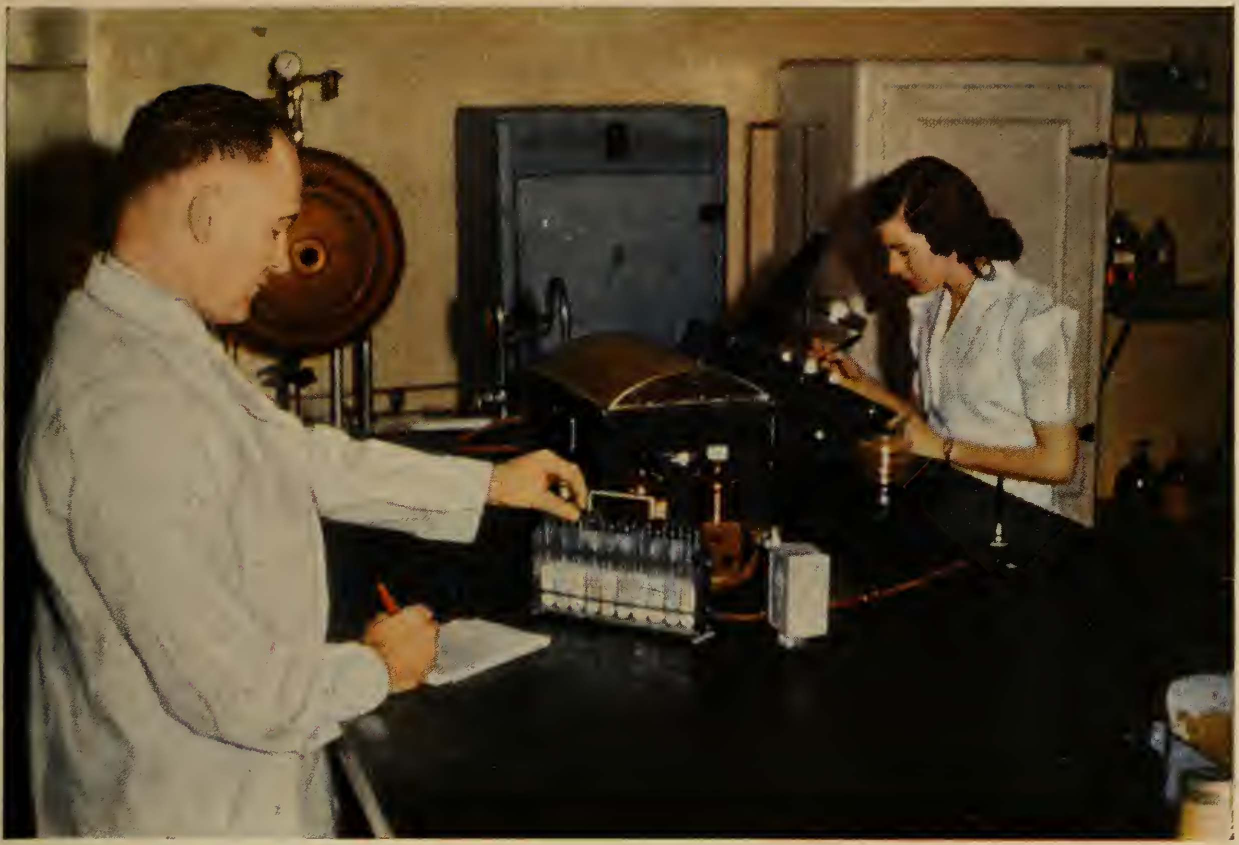


FIG. 12. Reading the Methylene Blue Test in a Milk Control Laboratory.

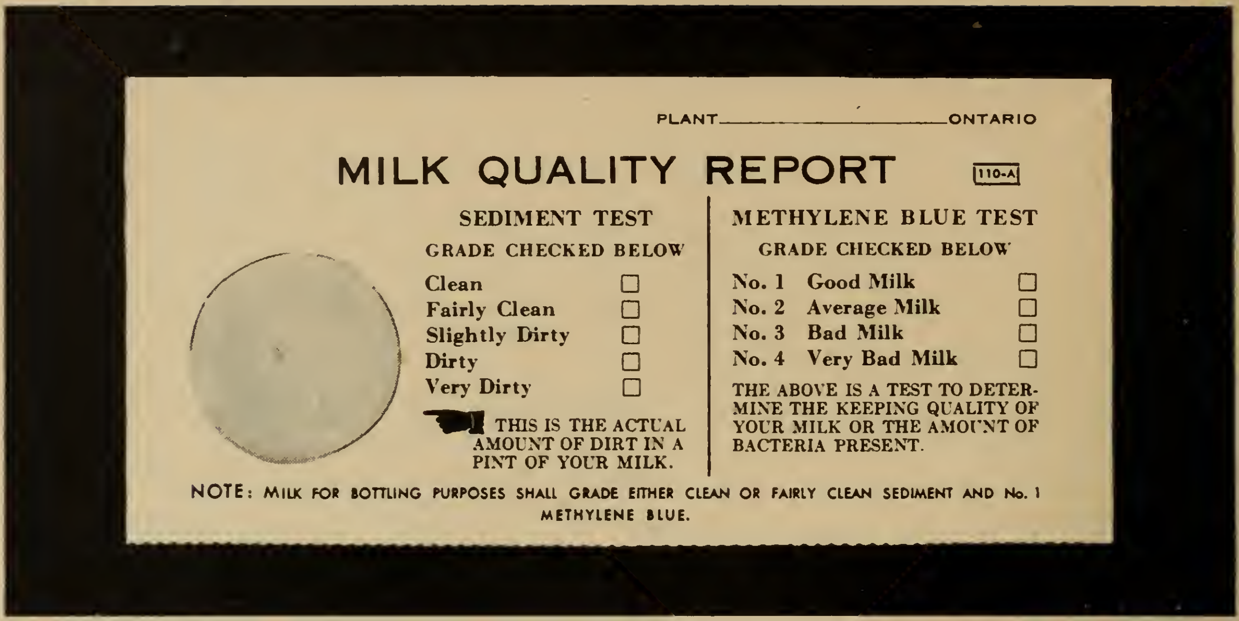
Transportation

Milk should be transported as rapidly as possible after removing the cans from the cooler. Covered transports avoid exposure of cans to road dust and help to keep the milk cool during transit. To avoid the possibility of the lids being removed or becoming loose, thus exposing the milk to contamination, the can should be sealed at the farm prior to loading.

MARKETING MILK FROM THE FARM

Essentials to the successful marketing of milk are fine quality and an adequate and uniform supply. If the consumer cannot be assured of a supply to meet his requirements then he must look to other foods readily available to supply his needs. The processors and distributors of dairy products provide to the farmer a service in the gathering together of the milk from individual farms, processing, packaging, storing and delivering it to the retail outlets or direct to the consumer. With a food as perishable as milk, the co-operation of the producers in providing the requirements fresh each day is very necessary.

Careful planning is necessary to maintain a uniform supply of milk throughout the year. These plans must include the maintenance of a healthy breeding herd, careful feeding of young and mature breeding stock, and a plan which aims at breeding as many cows and heifers to freshen in the fall of the year as possible. Fall and early winter freshening cows, under normal conditions, will produce more milk than cows freshening at other times of the year. In any herd there will be sufficient numbers of cows which, for various reasons, will have to be bred at other periods in the year which will aid in maintaining a uniform supply throughout the year.



PLANT____________________ONTARIO

MILK QUALITY REPORT 110-A

SEDIMENT TEST

GRADE CHECKED BELOW

Clean ☐
Fairly Clean ☐
Slightly Dirty ☐
Dirty ☐
Very Dirty ☐

☛ THIS IS THE ACTUAL AMOUNT OF DIRT IN A PINT OF YOUR MILK.

METHYLENE BLUE TEST

GRADE CHECKED BELOW

No. 1 Good Milk ☐
No. 2 Average Milk ☐
No. 3 Bad Milk ☐
No. 4 Very Bad Milk ☐

THE ABOVE IS A TEST TO DETERMINE THE KEEPING QUALITY OF YOUR MILK OR THE AMOUNT OF BACTERIA PRESENT.

NOTE: MILK FOR BOTTLING PURPOSES SHALL GRADE EITHER CLEAN OR FAIRLY CLEAN SEDIMENT AND No. 1 METHYLENE BLUE.

FIG. 13.

Paying For Milk At Dairy Plants

All dairy plants purchasing milk in the Province of Ontario are required to pay for the milk upon the basis of its weight and butterfat content as determined by the Babcock test. Each delivery must be weighed and sampled for the butterfat test. Usually the samples are preserved and accumulated to provide a composite sample representing the milk delivered during an established period. Dairy plants purchasing milk to be pasteurized and sold as bottled milk pay an agreed price for one hundred pounds of milk testing 3.4 per cent butterfat with a differential added to or deducted from the stated price for each one-tenth of a per cent which the individual producer's test may vary above or below the fat standard 3.4 per cent. Plants purchasing milk for manufacturing purposes establish the price based upon milk testing 3.5 per cent, making an adjustment in the price paid for milk varying from this standard in direct relation to the individual producer's test. In Ontario the established price is the result of a bargaining arrangement arrived at between representatives of milk producers' associations and purchasers of the milk, or in the event a satisfactory agreement cannot be reached the price for the area is established by a court of arbitration. (Ontario Dairy Products and Ontario Milk Control Acts.)

Determining Quality of Milk

Milk received at dairy plants is subjected to a number of tests to establish its fitness for the market. At the present time there are no established grades in Ontario for milk for all markets based on quality. However a number of dairy plants offer premiums for milk of superior quality and milk purchased for manufacturing purposes is graded into three grades as determined by the sediment test. The methods used to establish the quality of milk include:

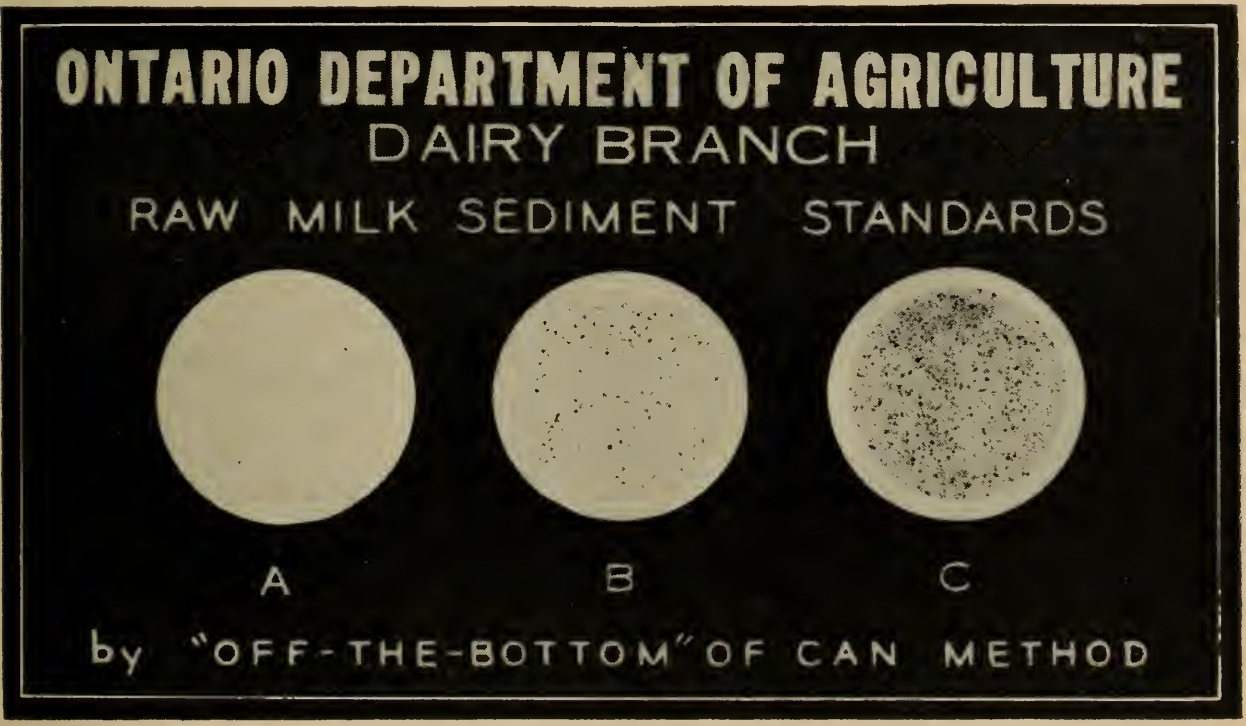
Inspection of farms;
Bacteria counts on milk as delivered;
Methylene Blue Reduction Test;
Resazurin Test;
Sediment Test;
Flavour and odour.

These tests, with the exception of examination for flavour and odour, are not applied to daily deliveries, but made periodically. It has been generally accepted that the sanitary quality of the milk shipped from a farm does not vary greatly from day to day. The personal factor in the production of good milk is so important that we would not expect great variations to occur with the same man in charge of operations. Therefore, the main objectives in applying these tests to milk deliveries is to classify the producers in such a way as to foresee the quality of milk which may be expected from each source, as well as to enable the dairy plant operator to advise the producer as to the quality of milk being produced by him and thus aid him in bringing about improvement.

Quality is the key to the progress and development of the dairy industry.

Quality can only be obtained through the application of sound practice and co-operation between the several branches of the industry.

FIG. 14. Ontario Sediment Standards for Manufactured Milk.


ONTARIO DEPARTMENT OF AGRICULTURE
DAIRY BRANCH
RAW MILK SEDIMENT STANDARDS
A
B
C
by "OFF-THE-BOTTOM" OF CAN METHOD

APPENDIX

BOVINE MASTITIS

by

Dr. D. A. Barnum, Ontario Veterinary College

Bovine mastitis is a disease that affects the mammary gland and is prevalent in all breeds of dairy cattle. The disease has been recognized for a long time but the incidence of infection has increased since the introduction of mechanical milking and the increased exchange of dairy cattle. The loss suffered by dairymen of Ontario due to this disease is estimated to be over one-quarter of a billion pounds of milk annually. Losses occur due to decreased milk production as infected quarters have impaired function. Many dairymen have experienced loss because the quality of the milk has been so affected by mastitis that it cannot be accepted by the dairy or milk processing plant.

Mastitis is an infectious disease—that is, it spreads from one cow to another and from one quarter to the next. The agent that causes the condition is usually one of a number of mastitis producing bacteria. The most common is *Streptococcus agalactiae,* although *Staphylococcus aureus* infection is frequently found.

The disease occurs in two forms, namely, acute and chronic mastitis.

Acute Mastitis

This form is easily recognized by the dairyman as the affected quarters are inflamed and swollen. The nature of the secretion will vary from milk with flakes and clots to a foul-smelling thick material. In some cases a watery yellowish discharge will be seen, depending on the type of bacteria that has invaded the udder. The bacteria may remain localized in the affected quarters or it may invade the blood stream, in which case the animal is acutely ill and has a high temperature.

If an acute case is left untreated the outcome will vary from impaired function or total loss of the quarter to death of the cow.

Treatment—As acute mastitis is a serious disease, treatment should be prompt and carried out by a veterinarian. He will decide what drugs are suited for the case and the method of their administration as treatment will depend on the causative bacteria. Until aid can be secured the quarter should be milked frequently, the animal stabled and the amount of feed reduced.

Prevention—Bacteria are the cause of the trouble so every method must be carried out to prevent their entrance into the udder. The elimination of chronic mastitis will aid. Injuries, chilling, and bruises are predisposing factors which aid the bacteria in their entrance, so every effort to prevent these must be carried out. Many cases are the result of using a dirty milking siphon.

Chronic Mastitis

Chronic mastitis is, as the name indicates, a chronic, mild inflammation of the udder. This type of mastitis is usually due to *Streptococcus agalactiae* and is highly infectious.

Symptoms—In many instances, chronic mastitis is not difficult to diagnose. The milk is abnormal as small pin-point flakes and small clots are observed on the strip-cup. There is more or less thickening of the quarter which results in a drop in production. The diseased tissue is gradually replaced by scar tissue that is incapable of secreting milk. Occasionally, a "flare-up" occurs when the quarter is swollen and production is down. This "flare-up" may subside only to be followed by another in a few weeks.

Diagnosis—A percentage of the cases can be diagnosed by the clinical symptoms but many quarters are infected and cannot be detected without special tests. These hidden cases cause a gradual loss in milk production and form a source of infection for healthy animals.

There are a number of field or barn tests such as the brom-thymol blue test papers that have a certain value in diagnosis but many cases are missed and false positives occur at the freshening and drying periods. The bacteriological examination of a sample taken in an aseptic manner is the best, as the infecting germ can be found. A microscopic examination aids in revealing chronic inflammation.

Treatment—The treatment of chronic mastitis was usually unsatisfactory before the advent of antibiotics. Since their introduction they have been found to be effective in 80 to 100 per cent of the cases treated. A number of antibiotics are used, the principal one being penicillin. They are administered in various forms such as bougies, ointments or in solution. Any of the methods are satisfactory providing the drug is present in the udder for at least three days in a sufficient concentration. The recommendations on treatment should be carefully followed, so it is advantageous to have the treatment carried out or supervised by a veterinarian.

Prevention and Control

The saying "An ounce of prevention is worth a pound of cure" applies to chronic mastitis and a program of mastitis control pays dividends. It is useless to eliminate the mastitis bacteria from one quarter by treatment and have it become re-infected from a positive animal. The following points are part of a control program:

A. **Clean Milking Practices**—Clean milking practices prevent the spread of infection from one animal to another by the milker or the milking machine. These practices have been outlined in this bulletin and must be followed at each milking period. Dipping each teat in a cup of disinfectant after milking is also a recommended practice. The equipment must be kept clean and sterilized between each milking.

B. **Herd Management**—Good herd management eliminates many of the predisposing causes of mastitis. A healthy animal in comfortable quarters is less susceptible to mastitis. Pen stabling is considered to reduce the number of injuries that affect the udder and teats.

C. **Diagnosis**—The submission of samples of milk taken in sterile vials to the laboratory**, is the best method of diagnosis. The daily use of the strip cup by the dairyman will detect early clinical cases by the appearance of clots and flakes.

D. **Treatment of Infected Quarters**—All infected quarters should be treated under the supervision of a veterinarian by the appropriate antibiotic. As most of the antibiotic inserted into the udder is eliminated in the milk, milk from treated animals should not be included in the milk shipment. This antibiotic will interfere with the processing of the milk (e.g. cheesemaking.)

E. **Segregation and Isolation**—Infected animals should be placed together at the end of the milking line. As first-calf heifers are usually free of infection, they should be milked first. All new cows purchased as herd replacements should be carefully examined to determine if they are healthy and mastitis free.

** Veterinary laboratories for the examination of milk samples for mastitis infection are maintained by the Ontario Department of Agriculture at the Ontario Veterinary College, Guelph, Ontario, the Kemptville Agriculture School, Kemptville, Ontario, and the Ridgetown Experimental Farm, Ridgetown, Ontario. Consultation on herd mastitis problems can be arranged through veterinary practitioners.

Public Health Importance of Mastitis

Fortunately most of the organisms that cause mastitis are not harmful to humans. However outbreaks of sore-throats in humans have occurred from the consumption of milk from mastitis cows where the infection was the streptococcus of the human type. This organism is killed by pasteurization. Some outbreaks of food poisoning have been attributed to milk that contained the toxin produced by the staphylococcus and this organism is often the cause of mastitis.

Milk for human consumption and for use in dairy products must be of high quality and to secure this, the milk must come from healthy udders.

KETOSIS IN DAIRY COWS

by

Dr. J. Henderson, O. V. College

Ketosis (acetonemia) is one of the most serious disease problems confronting dairymen in this Province. In many herds it causes heavy financial loss each year, particularly during the winter months, through lowered production, off flavoured milk and occasional deaths.

Ketosis is not always a separate disease but may occur as a complication. In these cases it would appear that the primary disease causes a drop in appetite which in turn brings on Ketosis. It can be produced in a high yielding cow by starvation and, no doubt, some field cases are due to inadequate amounts of feed. However, many cases occur when no primary cause can be determined and it is generally assumed that a deficiency of some specific nutrient is responsible. On some occasions cobalt deficiency has been associated with Ketosis but this cannot account for all our cases.

The condition is characterized by a high level of ketone bodies (fat breakdown products) and low level of sugar in the blood. This indicates a switch from carbohydrates to fat as the principal source of energy for the cow and it appears to be the essential feature of the disease. This excessive burning of body fat causes rapid loss of condition and frequently this is the first symptom observed, along with partial loss of appetite and lowered milk production. A sweetish chloroform-like odor may be noted from the breath and milk. A degree of constipation usually accompanies the condition. Severely affected cows may be dull and depressed although occasionally nervous symptoms such as licking the manger or fore legs, staggering or even convulsions have been observed. These nervous symptoms are definitely exceptions to the rule in Ontario.

In treating Ketosis, practising veterinarians generally use glucose or other agents intravenously and most cases respond favourably within a day or so. If a veterinarian is not available a drench of Epsom salts (1 lb.) followed by a pound or more of sugar twice daily and a tablespoonful of cobalt solution (prepared by adding 1 ounce of cobalt sulfate to a gallon of water) once daily may bring about improvement in some cases.

It is not possible at present to formulate a program of prevention which will be completely effective. However, the following points may assist in preventing the condition: (1) The practice of cutting off concentrates entirely for some days after calving is dangerous—energy should be supplied for current production. (2) Be sure that the ration is adequate in respect to both amount and composition. (3) Forcing for extreme production is dangerous since any slight upset may give rise to Ketosis. (4) When Ketosis is suspected have the cow examined and treated promptly by your veterinarian.

Ontario Dept. of Agriculture
RECEIVED
NOV 9 1953
Director of Research

HOUSE FLY CONTROL IN STABLES

by

S. E. Dixon, Dept. of Entomology and Zoology, O.A.C.

The control of houseflies in stables in many instances has proved difficult. In experimental work at the O.A.C. in 1950 satisfactory control was still obtained with DDT. While lack of control may in some cases be due to resistant strains of flies other important factors cannot be ignored. Lack of sanitation (too many breeding places), insufficient concentration and inadequate application of DDT spray must be considered. With regard to the latter it should be pointed out that if the spray is too diluted or inadequately applied the flies do not receive enough insecticide to kill them and thereby develop resistance.

However, where a particular insecticide does not give satisfactory control another should be used. Alternative sprays are listed below.

CONTROL

(a) Sanitation

Destroy the breeding places. Where farm operations permit, manure should be hauled out **once a week** or oftener and spread on the land. Haul out fresh manure first. Barn sprays are good but breeding must be reduced. Manure piles must **not** be sprayed with an insecticide since this tends to develop resistance more rapidly and to a higher degree.

(b) Screens

Milk houses should be screened, and stables and piggeries also, if practicable.

(c) Chemical Control

In all chemical control great care should be exercised to keep the insecticide from contaminating mangers, feed bins, water troughs, feed or any place that the cattle may lick. The insecticide should be applied as a coarse wetting spray to the walls and ceiling, about windows and doors, where the flies rest.

Insecticides may be applied by a **power sprayer** under very low pressure or by a **hand sprayer** of the wheelbarrow, knapsack, or two to three gallon compressed air type. A large whitewash brush may be used if a sprayer is not available. In all cases the walls must be wet to the run-off point. Fog or mist sprayers or aerosol types should not be used with the materials listed below.

(1) **DDT**

POWER SPRAYING AND HAND SPRAYING

DDT 50% Wettable Powder	1 lb.
Water	5 gal.

In hand spraying if the sprayer will handle higher concentrations such may be used. For brush use 1 lb. DDT 50% wettable powder to 2 gal. of water or use the 5% DDT in oil spray as purchased.

(2) **Lindane**

POWER SPRAYING AND HAND SPRAYING

Lindane 25% Wettable powder	1 lb.
Water	5 gal.

(3) **Methoxychlor**

POWER SPRAYING AND HAND SPRAYING

Methoxychlor 50% Wettable powder	1 lb.
Water	5 gal.

Emulsions of the above materials may be available. These will give satisfactory results if used in accordance with directions on the label.

Caution—The operator should exercise care in handling these materials. Read the label on the container carefully.

NOTE — These recommendations have been prepared in co-operation with the Division of Entomology, Canadian Department of Agriculture.

HORN FLY CONTROL ON CATTLE

Horn flies are the most common pests on cattle during the summer. These are small, dark, gray flies about half the size of house flies. They always rest on cattle with the head down and are most numerous over the withers.

These small flies breed in fresh cow manure but not in manure piles. The adults do not leave the cows except when they are laying eggs. Thus, to obtain control of this species, the cattle themselves must be treated.

Control

DDT and certain other insecticides leave a residue in the fat and milk of cattle which have come in contact with the insecticide. This can result from the cattle being sprayed or by feeding from mangers or drinking from water troughs which have accidentally been sprayed and may contain small quantities of the insecticide. Such residues in human food, especially those of DDT, must be considered as hazardous to the health of man. The presence of any such residue may result in a ban being placed on the sale of the contaminated products. At the present time strict regulations concerning such residues are actually in effect in the American market for beef and dairy products. Therefore, insecticides which will leave a hazardous residue must not be used on dairy cattle at any time or on beef cattle within three months of slaughter. Chlordane should never be applied to cattle.

Methoxychlor, piperonylbutoxide and pyrethrum, thiocyanates, and certain other mixtures are not regarded as hazardous and may be used on cattle where DDT is prohibited.

RECOMMENDATIONS FOR TREATMENT

(1) **Methoxychlor**—available as a 50% wettable powder

Power Spraying—

Methoxychlor 50% wettable powder	1 lb.
Water	12 gal.

Apply approximately ½ gallon per animal using about 250 lbs. pressure.

Hand Spraying —(Wheelbarrow, knapsack, or compressed air sprayer)

Methoxychlor 50% wettable powder	1 lb.
Water	12 gal.

Wet animals as thoroughly as possible.

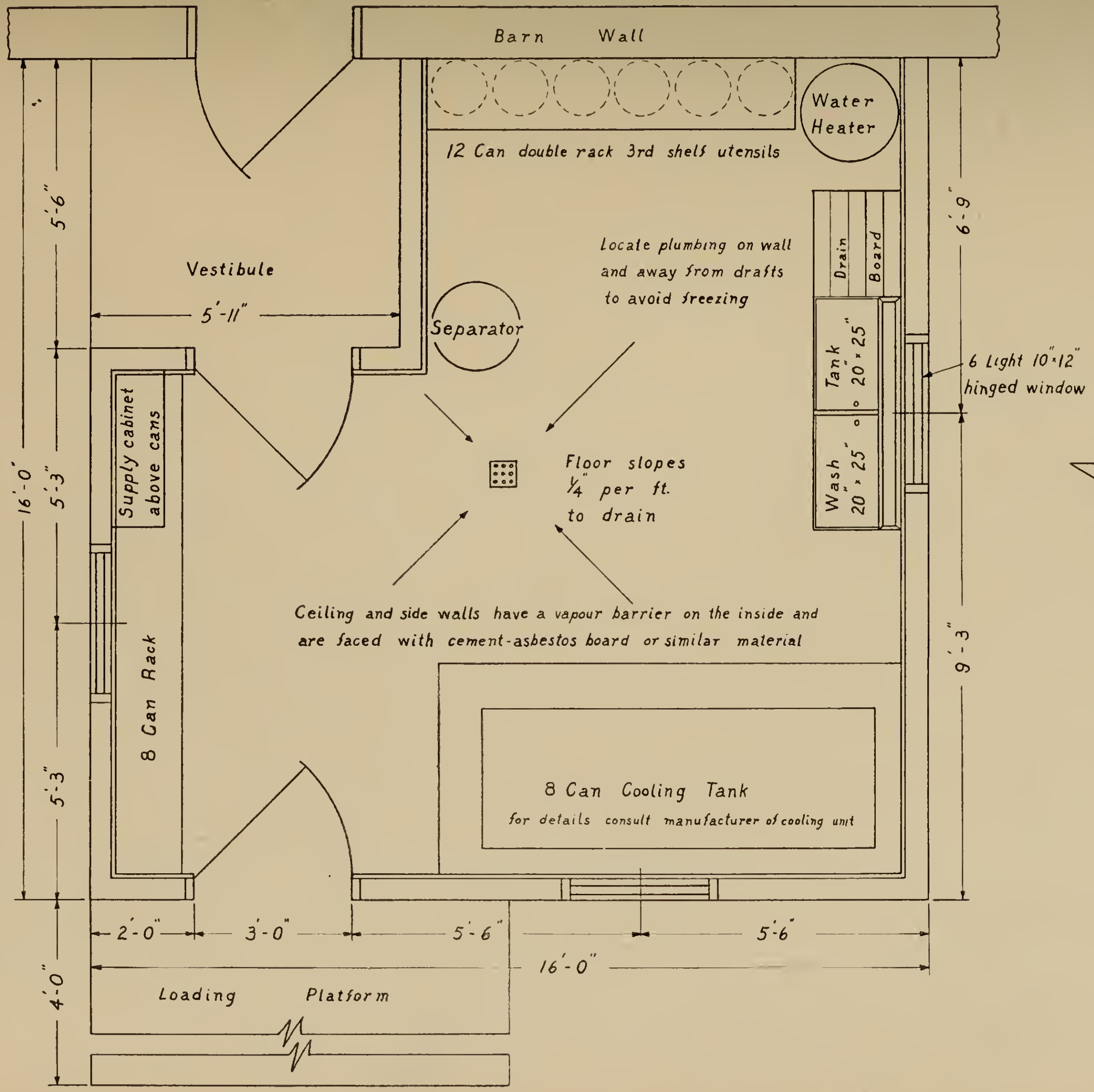
NOTE — Methoxychlor should give up to three weeks' protection.

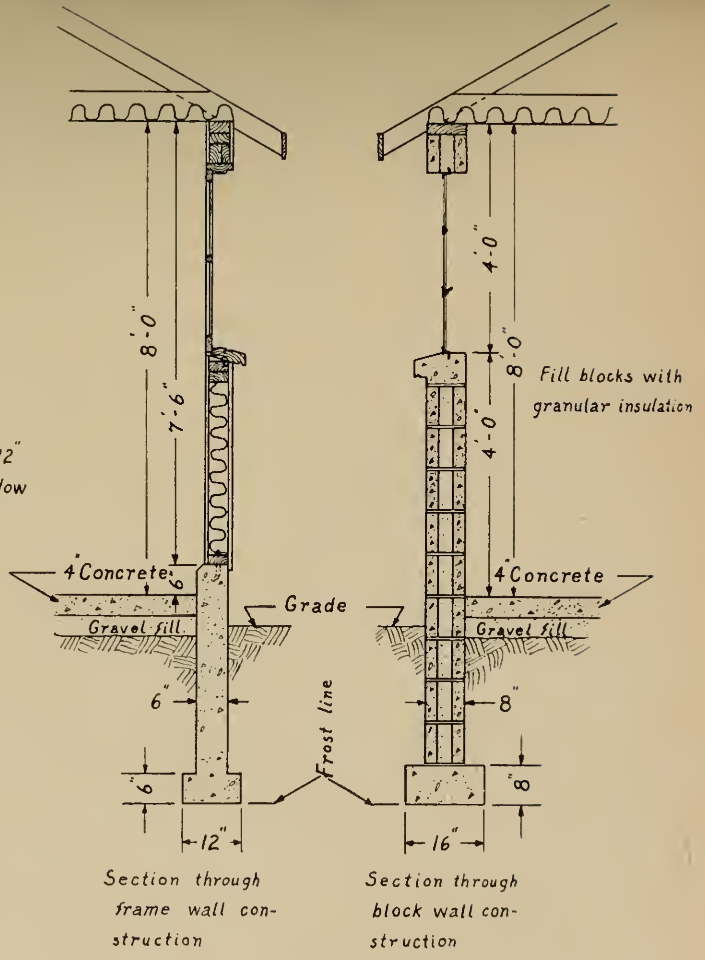
(2) **Piperonylbutoxide—Pyrethrum, Thiocyanates** and other mixtures.

These are available in oil-base commercial preparations and should be used according to manufacturer's directions. Such oil-base mixtures are not suitable for power spraying. They should be used only in small atomizing sprayers and should be applied as a mist over the animals or on the outer hair only. Animals must not be soaked with any oil-base spray. These insecticides, although not possessing the lasting effects of methoxychlor, do give a quick knock-down of flies followed by only a brief period of protection.

Certain commercial mixtures of this type (but not oil-base) may be available for power spraying.

NOTE — These recommendations have been prepared in co-operation with the Division of Entomology, Canadian Department of Agriculture.


Barn Wall
Water Heater
12 Can double rack 3rd shelf utensils
Drain
Board
Tank 20" × 25"
Wash 20" × 25"
6 Light 10"×12" hinged window
Locate plumbing on wall and away from drafts to avoid freezing
Vestibule
5'-11"
Separator
Supply cabinet above cans
Floor slopes ¼" per ft. to drain
Ceiling and side walls have a vapour barrier on the inside and are faced with cement-asbestos board or similar material
8 Can Rack
8 Can Cooling Tank
for details consult manufacturer of cooling unit
5'-6"
5'-3"
5'-3"
16'-0"
4'-0"
6'-9"
9'-3"
2'-0"
3'-0"
5'-6"
5'-6"
16'-0"
Loading Platform



Section through frame wall construction

Section through block wall construction

ONTARIO AGRICULTURAL COLLEGE

Guelph, Ontario

MILK HOUSE PLAN

SPECIFICATIONS FOR MILKHOUSE PLAN (M-H-2)

by

J. Pos, Dept. of Agr. Engineering, O.A.C.

Frame Wall Construction

Footing (60 Lin. feet)	Cement	6	sacks
	Sand	0.7	yards
	Gravel	1.0	yards
Foundation	Cement	27	sacks
	Sand	2.3	yards
	Gravel	3.6	yards
Floor	Cement	20	sacks
	Sand	2.0	yards
	Gravel	3.0	yards
Curb (under can racks)	Cement	3	sacks
	Sand	0.25	yards
	Gravel	0.4	yards

6″ x 6″ Bell trap and sufficient vitrified tile to drain floor and sink to convenient catch basin.

Loading Platform (4′ x 8′) this will depend upon the topography, but the maximum requirements are

Cement	7	sacks
Sand	1.2	yards
Gravel	1.7	yards

Walls	Sill	4 pcs.	2″ x 4″ x 16′	Spruce	
	Studs	25 ”	2″ x 4″ x 14′	”	16″ O.C.
	Plates	9 ”	2″ x 4″ x 16′	”	

Exterior Siding	500 board feet
Cement — Asbestos Board (or similar material)	500 square feet
Insulation	500 square feet, 2″ batts.
Window and Door Jambs	5 pcs. 2″ x 6″ x 14′ rabbeted pine
Window Sill	1 pc. 2″ x 8″ x 10′ rabbeted pine
Window and Door Trim	10 pcs. 1″ x 4″ x 16′ rabbeted pine
	3 sash 32″ x 36″, 6 light with hardware
	2 slab doors — 3′0″ x 7′0″ with hardware
Ceiling Joists	11 pcs. 2″ x 4″ x 16′ spruce, 24″ O.C.
Cement — Asbestos Board (or similar material)	260 square feet
Insulation	260 square feet 3″ batts (2′ lengths)

Roof

Rafters	22 pcs. 2″ x 4″ x 10′ spruce
Rafter Truss and Collar Ties	22 pcs. 1″ x 4″ x 10′
Sheathing	450 board feet
Shingles	4½ square
Lookouts	2 pcs. 2″ x 4″ x 16′, Spruce
Soffit	4 pcs. 1″ x 10″ x 10′, Pine
	2 pcs. 1″ x 10″ x 8′, Pine
Facio	2 pcs. 1″ x 6″ x 18′, Pine
	2 pcs, 1″ x 6″ x 12′, Pine

Alternative Block Wall Construction

FOOTING	Cement	11 sacks
	Sand	1.2 yards
	Gravel	1.7 yards
FOUNDATION AND WALL	450 8″ x 8″ x 16″ Standard Core Blocks	
	60 8″ x 8″ x 16″ 3 Core Corner Blocks	
MORTAR — 1-1-16	Cement	3 sacks
	Hydrated Lime	3 cu. ft.
	Sand	¾ yards
INSULATION	Fill Cores in Block with Granular Insulation	
PLATES	5 pcs. 2″ x 8″ x 16′, spruce	
WINDOW AND DOOR JAMBS	5 pcs. 2″ x 6″ x 14′, rabbeted pine	
WINDOW SILL	1 pc. 2″ x 8″ x 10′	
WINDOW AND DOOR TRIM	10 pcs. 1″ x 4″ x 16′, rabbeted pine	
	3 sash 32″ x 36″, 6 light with hardware	
	2 slab doors 3′0″ x 7′0″ with hardware	
FLOOR LOADING PLATFORM CEILING ROOF	Same as Frame Wall Construction	

Specifications for Wash Sink

2 pcs. ¼″ x 2″ x 52″ — Flat Iron — Frame
3 pcs. ¼″ x 2″ x 19½″ — Flat Iron — Frame
2 pcs. 1½″ x 1½″ x 33″ — ⅛″ Angle Iron — Front legs
2 pcs. 1½″ x 1½″ x 45″ — ⅛″ Angle Iron — Back legs
8 pcs. ¼″ x 2″ x 13¼″ — Flat Iron Cut Each End 45° Braces
2 pcs. 1″ x 1″ x 52¼″ — ⅛″ Angle Iron — Drying Rack
2 pcs. 1″ x 1″ x 5″ — ⅛″ Angle Iron — Drying Rack
1 pc. 4¾″ x 52″ Galvanized Metal Lath
2 Drain pipe adapters
2 Drop in place stainless steel sinks

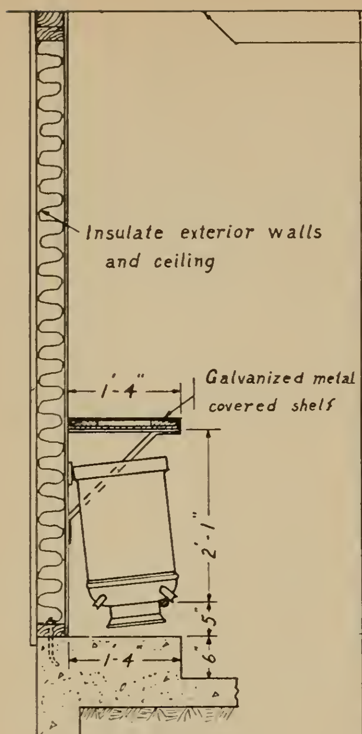
Specifications for Can Racks

A. SINGLE RACK WITH SHELF

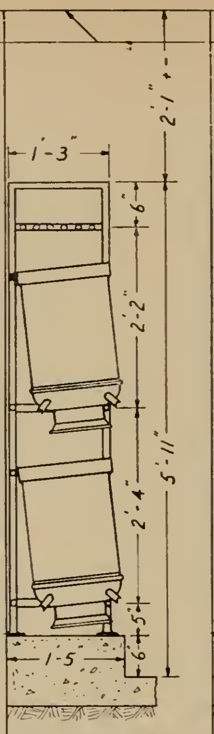
1″ Galvanized Iron Pipe — 10′
2 End Flanges for 1″ Pipe
1 pc. 1″ x 3″ x 10′ Spruce
4 Metal Brackets — 2′
2 pcs. 1″ x 4″ x 10′ Spruce
1 pc. ⅜″ Plywood 2′8″ x 10′0″
1 pc. 26 gauge galvanized metal 2′4″ x 10′0″

B. DOUBLE CAN RACK WITH TOP SHELF

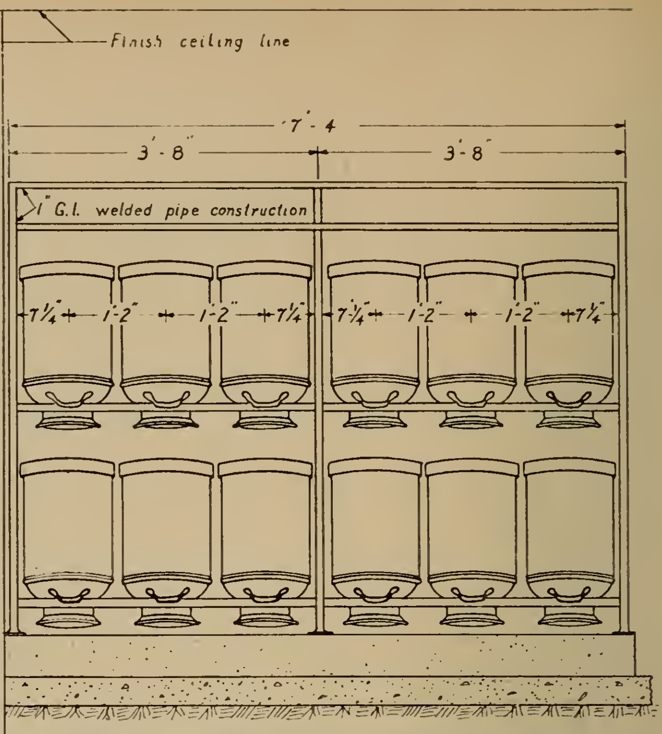
26 pcs. 1″ G.I. Pipe 3′7″
15 pcs. 1″ G.I. Pipe 12″
2 pcs. 1″ G.I. Pipe 15″
5 pcs. 1″ G.I. Pipe 5′5″
1 pc. 1″ G.I. Pipe 4′11″
1 pc. 1″ G.I. Pipe 7′2″
1 pc. 1″ G.I. Pipe 7′4″
6 end flanges for 1″ Pipe


Insulate exterior walls and ceiling
1'-4"
Galvanized metal covered shelf
2'-1"
5"
6"
1'-4

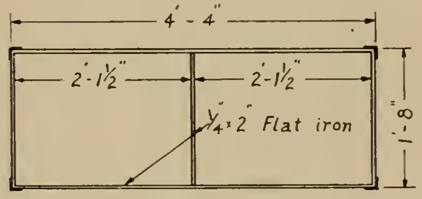
SINGLE CAN RACK



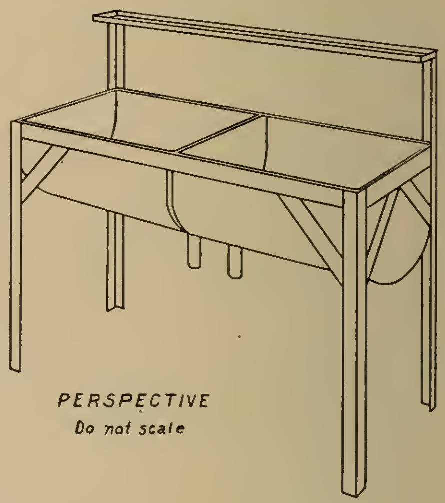
DOUBLE CAN RACK



FRONT VIEW DOUBLE CAN RACK, UTENSIL SHELF ON TOP

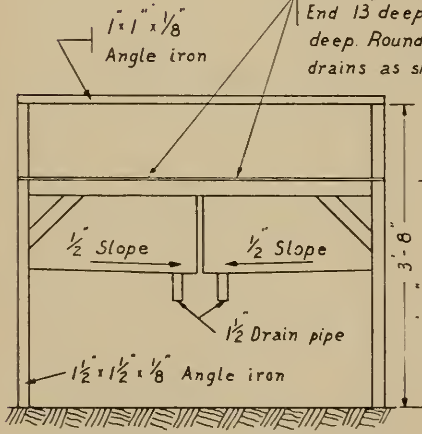


PLAN VIEW OF SINK

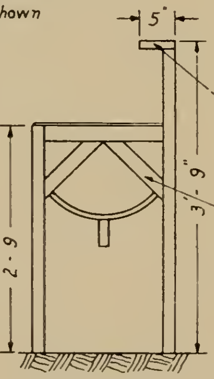


PERSPECTIVE
Do not scale

22 Gauge stainless steel drop in place sinks Edges rolled on ¼" cold rolled rod. End 13" deep - center 13½" deep. Round bottom with drains as shown



FRONT ELEVATION



SIDE ELEVATION

Drying rack, corners cut 45° and butt welded, expanded metal lath bottom should be galvanized

Corner braces ¼"×2" flat iron butt welded to frame and lap welded to legs

ONTARIO AGRICULTURAL COLLEGE
Guelph, Ontario
MILK CAN RACKS & WASHING SINK

CLEANING OF FARM DAIRY UTENSILS AND EQUIPMENT

by

L. R. Bryant, Chemistry Dept., O.A.C.

There are three separate operations involved in the proper cleaning of farm dairy utensils and equipment:

RINSE — Immediately after use thoroughly rinse with warm (not hot) water.

CLEAN — Use a suitable type of cleaning compound dissolved in warm water and flow through (milking machine and separator) or rinse with brushing (pails, etc.). Use a brush on all possible surfaces.

RINSE — Rinse to remove cleaning solution with clean warm or hot water. If a chlorine sterilizer is used it should be used only in the final rinse.

Types of Cleaning Compounds

A "suitable" type of cleaning compound as mentioned above will have to be chosen with regard to the kind of metal surfaces to be cleaned and to the water supply available.

Metals

Stainless Steel—Is resistant to practically all cleaning compounds likely to be used. In the case of chlorine sterilizing solutions it may be damaged by the use of chlorine solutions if these are made up many times too strong by mistake.

Aluminium and Tin—These metals are sensitive to strong alkalis or caustic solutions. An alkaline type of cleaning compound for use on these metals should contain some form of sodium silicate in which case these cleaning compounds are reasonably safe. Such alkaline materials as trisodium phospate, sodium carbonate and particularly caustic soda should not be used alone on these metals.

Galvanized Metal—(such as galvanized pails, etc.) should not be used in the farm dairy at all.

Water Problems

The choice of a cleaning compound will also depend to an important extent on the kind of water supply available. Generally speaking, a hard to very hard water supply will require the use of a somewhat more expensive type of cleaning compound than a soft water.

The usual components of a cleaning compound for this kind of use are:

(1) A mild alkali such as sodium carbonate or trisodium phosphate plus sodium silicate where the cleaner is to be used on aluminum or tinned surfaces. These materials possess general cleaning properties, such as the ability to dissolve casein deposits, to emulsify and partially saponify fats, and to disperse these throughout the rinse solution so that they will rinse fairly readily from the surface. They also possess the disadvantage of forming scale deposits with hard water.

(2) Various kinds of polyphosphates. These materials prevent the deposition of hard water scale and promote dispersion of the milk fat and solids in the cleaning solution.

(3) Synthetic Detergents (of the type of "Vel", "Dreft", etc.). These materials promote cleaning, dispersion and free rinsing. They are unlike ordinary soap in that they do not form "curds" with the hardness in the water.

The first of the above components of a cleaning compound are the cheaper ingredients. The second and third are somewhat more expensive. A cleaning compound for use in soft water may contain less of the polyphosphates and is therefore cheaper than one intended for hard or very hard water which must contain considerably more of these ingredients.

On no account must any cleaning preparation containing ordinary soap be used for washing farm dairy utensils.

Sources of Supply

(1) Dairies, Creameries, Cheese Factories, Condenseries, etc. The processing plant to which the farmer sends his dairy products may purchase cleansers of the right type from their supply house and distribute them to their patrons.

(2) All United Co-operative Stores in Ontario carry a line of cleansers from which a suitable one may be chosen.

(3) Many feed stores stock cleaning compounds of the type described.

(4) Most Dairy Supply Companies can obtain suitable cleaning compounds.

In localities where the water supply is soft successful cleaning may often be accomplished by the use of synthetic detergents by themselves.

Acid Cleaning

There is an advantage in the occasional use, say once a week, of acid cleaning compounds for cleaning farm dairy utensils and equipment. This advantage comes from the ability of the acid compounds to remove any hard water scale which may have been deposited and, possibly, the breaking of the continuity of bacterial build-up which may have taken place under alkaline conditions. Suitable acid cleaners are those which contain a weak organic acid plus a synthetic detergent. Sources of supply are practically the same as in the case of alkaline type cleaners with the exception of feed stores. These acid cleaners are often in liquid form, whereas the alkaline types are usually powders.

Sterilization—Occasionally it is necessary or desirable to sterilize equipment. Some operators make it a regular daily practice. In the case of milking machine inflations it is always necessary to sterilize and the Johns Method of sterilization with caustic soda or lye solution is the most reliable method. Milking machine pails, separators, and pails usually benefit from sterilization with chlorine preparations which should be carefully and freshly made up in accordance with the directions for the particular preparation. These chlorine preparations may be obtained from the same sources of supply as the cleaning compounds. One should be particularly careful in the case of chlorine solutions that **all** of the solid is thoroughly dissolved and that the solution is completely mixed or stirred before use.

This also applies to powdered cleaning compounds. The chlorine solutions should be used as a final rinse after the surface has been rinsed free of cleaning solution.

There is another type of sterilizing compound available namely the quaternary ammonium compound (of the type of "Roccal"). If this kind of sterilizer is used occasionally as an alternate with chlorine compounds or alone without alternation, all traces of cleaning solution containing synthetic detergents should be thoroughly rinsed away from the surface **before** the quaternary type sterilizing solution is used.

CARE AND MAINTENANCE OF THE MILKING MACHINE

The modern milking machine and cream separator is called upon to serve 365 days of the year, a demand that is made of possibly no other farm machine except the water pump. To make possible this uninterrupted service, care must be taken to see that they are properly installed and maintained.

The milking machine of to-day is a marked improvement over the early machines and is the result of careful designing and progressive improvement. The early machines depended upon pressure or suction to perform the milking. The modern machine combines these two actions applying controlled suction and gentle pressure to the teat, the result being quite similar to the action of the sucking calf.

The successful use of the milking machine depends greatly upon the operator. He must at all times keep in mind that he is operating a mechanical device on an extremely sensitive living animal. This means that a first class mechanic may be a poor milking machine operator, and that a good husbandman to operate the milking machine successfully must be a bit of a mechanic.

While the agent's mechanics usually install the machine, there is no reason why any handy man might not install his own. It is wise to have the motor and pump firmly fastened to a platform hung from the ceiling at a convenient height and as near the milking line as possible. All unnecessary pipe line should be avoided.

Installing Pipe Line

If available, use galvanized 1″ pipe, otherwise black iron pipe will serve. Install a drain trap in the line a few feet from the pump, and place the vacuum controller and gauge at a central point between the pump and end of line. Cut piping in proper lengths, thread and see that all ends are reamed. If measurements are carefully made this work may be done at a machine shop or plumber's shop. The usual custom is to have one stall cock between each pair of cows. A 1″ x 1″ x ⅜″ tee is placed in the vacuum line where a stall cock is required. The vacuum lines should be hung with a slight fall to the end of each milking line nearest the pump where a moisture drain valve should be located. A stall cock should be placed in a convenient location for flushing out the machine after the milking is completed.

It will help in ordering materials and installing if a diagram is made of the proposed installation including the proper number and location of stall cocks, elbows, tees, drain valves, vacuum control and gauge. The length of pipes required to make proper connections may be included.

If a magnetic type of milker such as the DeLaval Magnetic Milker is being installed an insulated wire is connected at the generator and laid to follow the vacuum line with contact made at each stall cock. These contacts should be soldered and wrapped.

All pipe joints should be well made using no paint on the thread. After installation is complete start vacuum pump and put fresh paint around each connection. The paint will be drawn into the joints to seal any leaks.

Two types of vacuum pump are in common use—rotary and piston style. The vacuum maintained on the line varies somewhat with the different makes and care should be taken to see that the recommended vacuum is maintained. The common range of vacuum is from 10″ to 18″. Considerable injury to cows may result from milking with vacuum too high or too low. The automatic vacuum control is the safest means of controlling vacuum. If the vacuum is too low, a leak in the line, probably at a joint or faulty stall cock is the cause or the pump may be running below the recommended speed. If the vacuum is too high, dirt on the stem of the vacuum controller may be retarding its normal movement or dust on the screen may prevent the inflow of air.

Care of Pump

Have the oil at the proper level at all times. Once each month drain the oil, flush the pump with coal oil and refill. Check the belt and see that it is tight and not showing serious wear. A broken belt during milking will delay the milking and thus disturb the cows. A worn or loose belt may cause slippage and reduce the vacuum.

Care of Line

At least once a month or after milk is known to have been drawn into the line, wash the line and trap out by drawing a pail of hot water, to which a strong washing powder has been added, through the entire line to the trap. Be careful not to use more water than trap will easily hold. Empty the trap and rinse by drawing another pail of clean hot water through. Thoroughly dry the trap and occasionally paint the inside to prevent rusting.

Care of Pulsators

The pulsator is the heart of the machine. Handle it carefully. Keep the pulsator clean and follow the directions given by the manufacturer for its care.

Care of Pails and Milking Parts

(See The Lye Method of Maintaining Milking Machine Parts.)

Milking Hints

Keep proper tension on rubber teat cup liners and replace when they become cracked or soft.

Wipe the udders and teats off with a damp cloth just before putting the milker on. Use a strip cup (a dark cloth over a dipper) and draw a few streams of milk from each quarter before putting the milker on. In this way udder infection may be detected before serious trouble develops.

Do not leave the machine on cow longer than five minutes. The cow will adjust herself to the shorter milking time. To leave the machine on after milking is completed irritates the udder and tends to dry the cow. An alarm clock in the stable is a help to control the time.

Milk at regular intervals and if possible milk cows in the same order; start at the head of the line and milk in rotation. An exception to this practice is that cows with any signs of udder trouble should be milked last. If mastitis is prevalent dip teat cups in a chlorine solution before putting the teat cups on the next cow.

THE LYE METHOD OF MAINTAINING MILKING MACHINE PARTS IN A CLEAN SANITARY CONDITION

Lye Method: (Cold water and lye solution)

Extensive experiments have resulted in the development of a method which has given complete satisfaction without the use of hot water for washing or sterilizing the rubber parts. The following is a description of the method:

Immediately following the milking of the last cow, a pailful of clean cold or luke warm water is sucked through the teat cups and tubes of each unit. The teat cups are raised and lowered so that air and water alternately surge through the tubes. This causes greater expansion and contraction and removes more of the milk residue. (This suction method is equally as effective as brushing the tubes.) Next, the long milk tube is disconnected from the pail head, and the teat cups and tubes hung up on a solution rack. The teat cups and milk tubes are then completely filled with a weak solution of common lye. The solution is left in the tubes until the next milking, then drained out thoroughly and used to scrub down the milk house floor. The milk pails and heads are washed and sterilized along with the other metal utensils, immediately after using. In order to prevent the rubber tubing from sticking to the metal parts, the milk tube system should be taken apart once a week. Check valves, vacuum lines, etc., should be cleaned regularly.

The fact that no hot water is required for washing and sterilizing the rubber parts makes it well suited to average farm conditions, where only a limited quantity of hot water is available. The lye solution has the following advantages:

1. It prevents the growth of bacteria and kills many of those remaining after the suction rinsing.

2. It removes traces of fat and other milk solids, leaving the rubber parts sweeter and cleaner and lengthening their life.

3. Lye can be bought at any grocery or general store; the solution is easily prepared; and costs less than 1¼ cents per gallon.

4. Lye solution, unlike hypochlorite, does not lose its strength when in contact with milk residue or rubber.

As against the advantages mentioned, there are two disadvantages:

1. Lye, like other alkalis, corrodes aluminium. This method should not be used on machines having aluminium parts in the milk tube system. Aluminium pails are not affected as the solution does not come in contact with them.

2. If the suction rinsing is not done thoroughly, small amounts of milk residue may remain. The lye solution will then throw down a precipitate of calcium phosphate, and a granular deposit will slowly build up on the inner walls of the inflations. This will rarely be found except under very careless conditions.

The first disadvantage may be met by using sodium metasilicate, which does not corrode aluminium, in place of lye. The second can be avoided by using larger quantities of water to rinse the tubes, and particularly by rinsing immediately before the milk has a chance to dry onto the rubber. If a deposit should appear, it can easily be removed by soaking in vinegar or by using one of the weak acid cleaners available on the market.

**Preparation of Lye Solution

(a) **Stock solution:** Dissolve 3 tins of good grade lye in 4 quarts of cold water. On account of the intense heat which develops, it is best to use an enamel pail. This is the "Stock Solution" and should be kept in a tightly-stoppered glass or earthenware jar stored away from the reach of children.

(b) **Soak solution for filling milk tube system:** Take 4 ounces of stock solution and dilute with clean cold water to 4 quarts. This should give a solution containing slightly less than one-half of one percent of lye, having a distinctly slippery feel.

The solution rack method is strongly recommended in place of the older method where the tubes were placed in a large crock. Less solution is required, and a fresh quantity of fresh solution at full strength is used at each milking. It also avoids trouble due to air pockets in the tubes in the crock method, whereby portions of the tube escape contact with the solution. Less space is also required in the milk house.

A number of milking machines are equipped with large cone-shaped aluminium pails. It has been found that after sterilization, when these pails are inverted on a rack in the milk house they are often found to be moist on the inside during the entire period between milkings. If these pails are inverted for a short time so that most of the water will drain off and then placed on their side, the inner surfaces will soon become thoroughly dry.

** Copy from report of Committee on Dairy Farm Methods, International Association of Milk and Food Sanitarians.

The writer wishes to acknowledge the co-operation given by the Public Relations, Photographic Extension Dept., O.A.C., in securing the illustrations used in this bulletin.

●

BULLETIN 485 APRIL 1952

GROWING VEGETABLE TRANSPLANTS

•

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

PAGE

INTRODUCTION - 1

FRAMES FOR HOTBEDS AND COLDFRAMES - 1
  Single-Sash Frame - 1
  Double-Sash Frame - 2

MANURE-HEATED HOTBED - 4
  Preparation of the Manure - 4
  Placing the Manure in the Hotbed - 4
  Placing the Frame on the Manure - 4
  Placing the Compost Soil in the Hotbed - 5
  Time of Seeding and Planting - 5

HOT-WATER-HEATED HOTBED - 5

STANDARD AND SASH GREENHOUSES - 5

CLOCHES - 6

PAPER PLANT PROTECTORS - 7

SOIL - 7
  Compost-Pile Method of Preparing Soil - 7
  Soil, Peat, and Sand Mixture - 8
  Sterilizing and Disinfecting Compost Soil - 8
  Bench Method - 8
  Box Method - 9
  Temperature - 9
  Formalin - 9
  Other Chemicals - 9

PLANT CONTAINERS - 10
  Wooden Flats - 10
  Clay Pots - 10
  Plant Bands - 10
  Soil Blocks - 11

PLACING COMPOST SOIL IN THE FLAT - 11

VEGETABLE SEED TREATMENTS - 12

GROWTH OF YOUNG PLANTS AFTER TRANSPLANTING - 12

HARDENING YOUNG VEGETABLE PLANTS - 12

PLANT PRODUCTION - 12
  Cabbage - 13
  Brussels Sprouts - 14
  Sprouting Broccoli - 14
  Cauliflower - 14
  Celery - 15
  Eggplant - 17
  Lettuce - 18
  Muskmelon - 19
  Onion - 20
  Pepper - 21
  Tomato - 22

GROWING VEGETABLE TRANSPLANTS

by

T. H. Jones and J. S. Shoemaker

Department of Horticulture, Ontario Agricultural College, Guelph, Ontario

---

INTRODUCTION

Production of vegetable seedlings under glass and subsequently transplanting them to the garden or field is the usual practice in Ontario to provide the longer growing season needed for tomato, pepper, and eggplant, and to permit early harvesting of crops of the cabbage family, celery, lettuce, beet, and cucurbits. The purpose of this publication is to provide information on the methods and structures used in starting vegetable plants under glass for transplanting outdoors.

FRAMES FOR HOTBEDS AND COLDFRAMES

The single-sash frame and the double-sash frame, each composed of durable wood such as white pine, are used in making both hotbeds and coldframes. Frames should be located close to an ample water supply, and should not be exposed to strong winds. A well-drained site is essential.

THE SINGLE-SASH FRAME

In the single-sash frame, a single line of glass sash composes the "roof".

Standard Glass Sash

Standard glass sash is 6 feet long and 3 feet wide. Each glass pane may be 7 by 9 inches, 10 by 12 inches, or 10 by 14 inches in size.

Two types of glass are used for hotbeds and coldframes. The double-diamond glass is ⅛ inch thick and weighs 24 ounces per square foot. The single-diamond glass is 3/32 inch thick and weighs 18 ounces per square foot. Both types transmit all the light rays which are essential for plant growth.

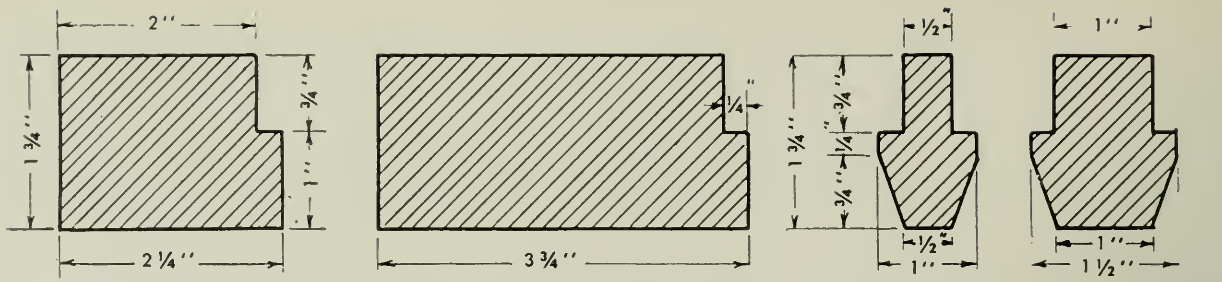
Placing the Glass in Position

The glass usually is puttied to the wood of the sash. To do this, putty is evenly distributed in the putty grooves. Then the glass is placed in position by lapping it at the ends by ¼-inch and pressing it into the putty. Two glazing nails, one at each side of each pane of glass, are driven into the wood to keep the glass in place.

The glass sash is situated between, and rests upon, two parallel sash bars. It is moved up and down on these sash bars to control temperature, to afford ventilation, and to permit seeding and other operations.

Sides and Ends of Frame

The sides and ends of the single-sash frame are usually made of 1-inch, tongue-and-groove lumber. The frame should face south for maximum sunshine.

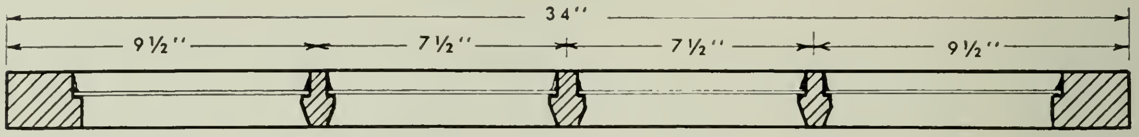


SECTION THROUGH THE TOP RAIL AND STILES

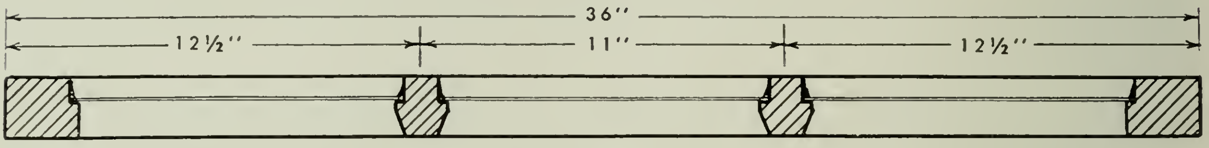
SECTION THROUGH THE BOTTOM RAIL

SECTION THROUGH MUNTIN FOR 34" SASH

SECTION THROUGH MUNTIN FOR 36" SASH



SECTION THROUGH 34" WIDE SASH USING 7"X9" GLASS



SECTION THROUGH 36" WIDE SASH USING EITHER 10"X12" OR 7"X9" GLASS

FIG. 1. Section of glass sash. (Drawn by Professor E. W. Kendall, retired.)

A standard single-sash frame is 18 inches high at the rear and 12 inches high at the front. The height may be increased for comparatively tall plants, to 25 inches at the rear and 19 inches at the front.

The sash bars are fitted flush with the tops of the north and south sides to carry the sash and to strengthen the sides. The sash bars are spaced to carry the width of the sash. They are usually 3 inches wide, 2 inches thick, and with a 1½-inch-wide by 1-inch-thick strip separating the sash.

The Double-Sash Frame

The "roof" of the double-sash frame consists of one row of 6 x 3 feet standard hotbed glass sash on each side of a ridge pole. Standard glass, as described previously, is used. This type of frame can be made high enough to permit a person to work inside.

Sides and Ends of Frame

In the double-sash frame the sides are the same height. This height may be from 18 to 26 inches, according to the preference of the grower. The distance between the sides is commonly 11 feet, 11 inches. The perpendicular height at the ridge pole varies from 30 to 36 inches with different growers. The sides are made of 1-inch lumber.

Ridge Pole and Cap

Midway between the sides, and spaced 8 feet apart, are upright 5-by-5-inch wooden posts or pipes. On top of these posts or pipes is a 2-by-6-inch ridge pole. The sash bars, which support the glass sash, are 3 feet apart, and fit between the top of the side of the frame and the ridge pole.

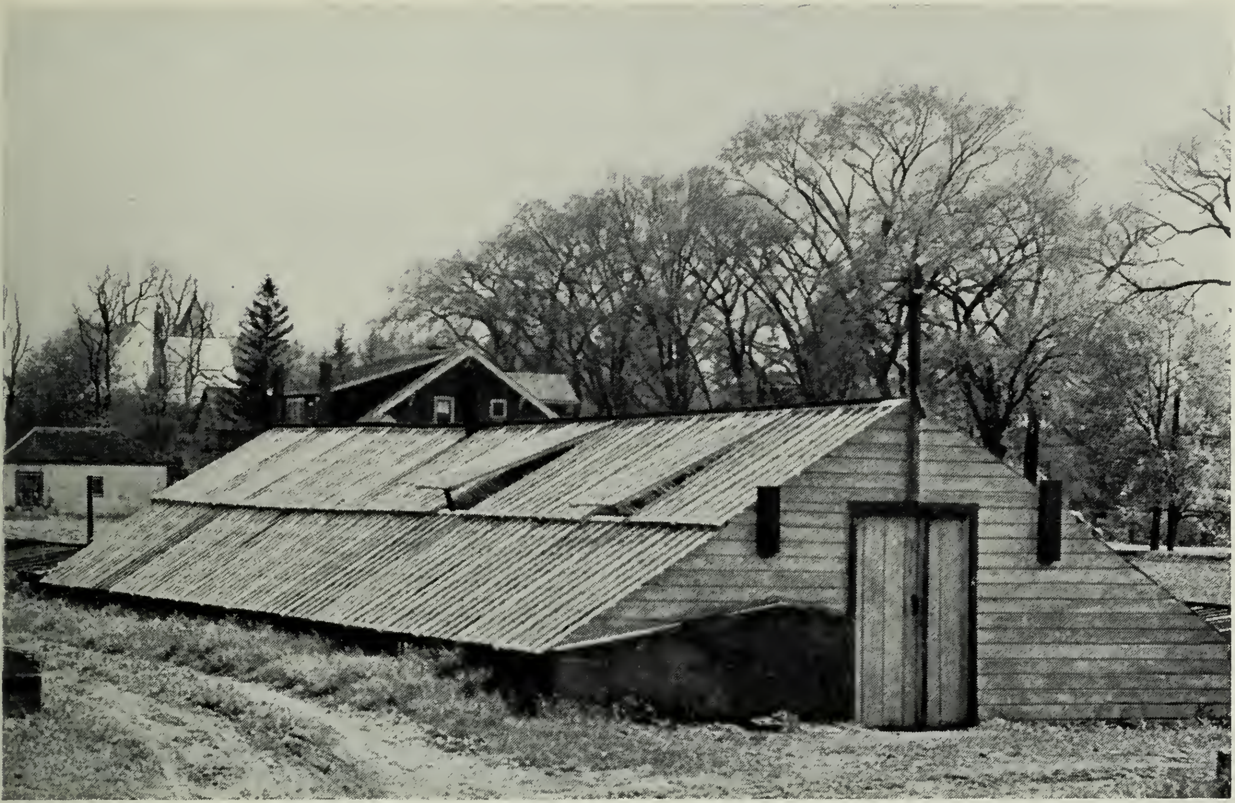


FIG. 2. Double-sash greenhouse. The roof consists of two rows of 6 x 3 foot standard hotbed glass sash. Flats containing seeds or young plants are placed on the ground beds in this instance. Ventilation is effected by raising the sash at each side of the roof.

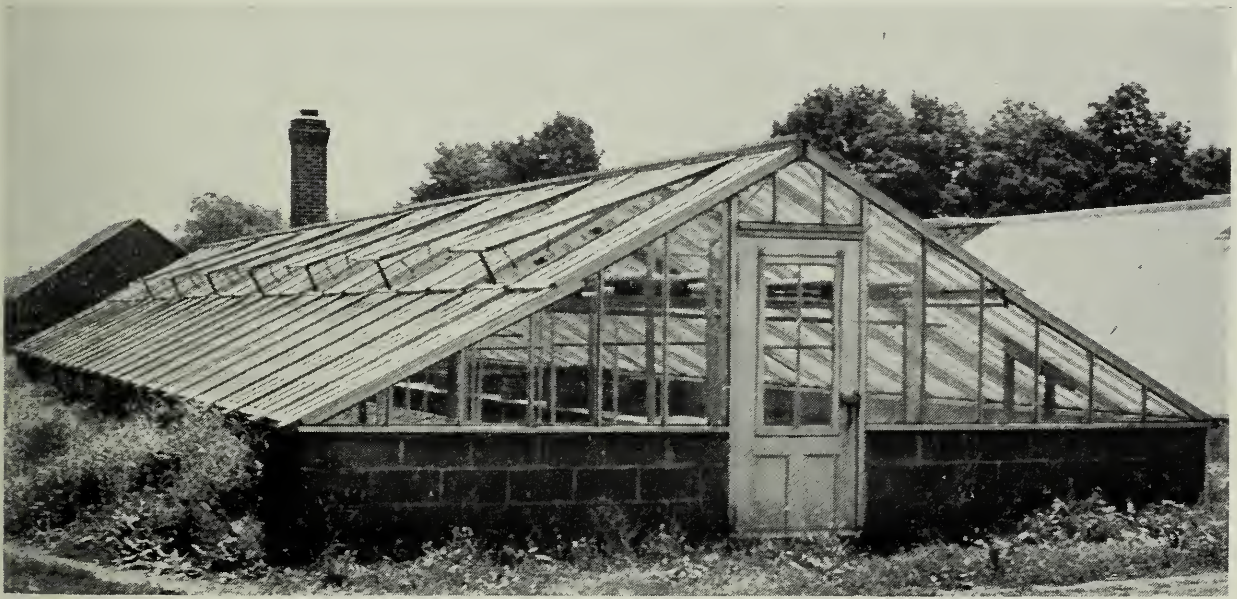


FIG. 3. Double-sash greenhouse. Standard hotbed glass sash 6 x 3 feet are in 2 rows on each side of the roof. Ventilation is effected by raising the sash at each side of the roof. A wooden bench at each side and a raised ground bed in the centre, with a narrow passageway between side bench and centre bed, are used in this instance. Flats containing seeds or young plants are placed on the bench and bed.

A 6-inch-wide and 1-inch-thick board called a ridge cap covers the junction of the glass sash and the ridge pole. It serves to prevent moisture from entering the hotbed or coldframe.

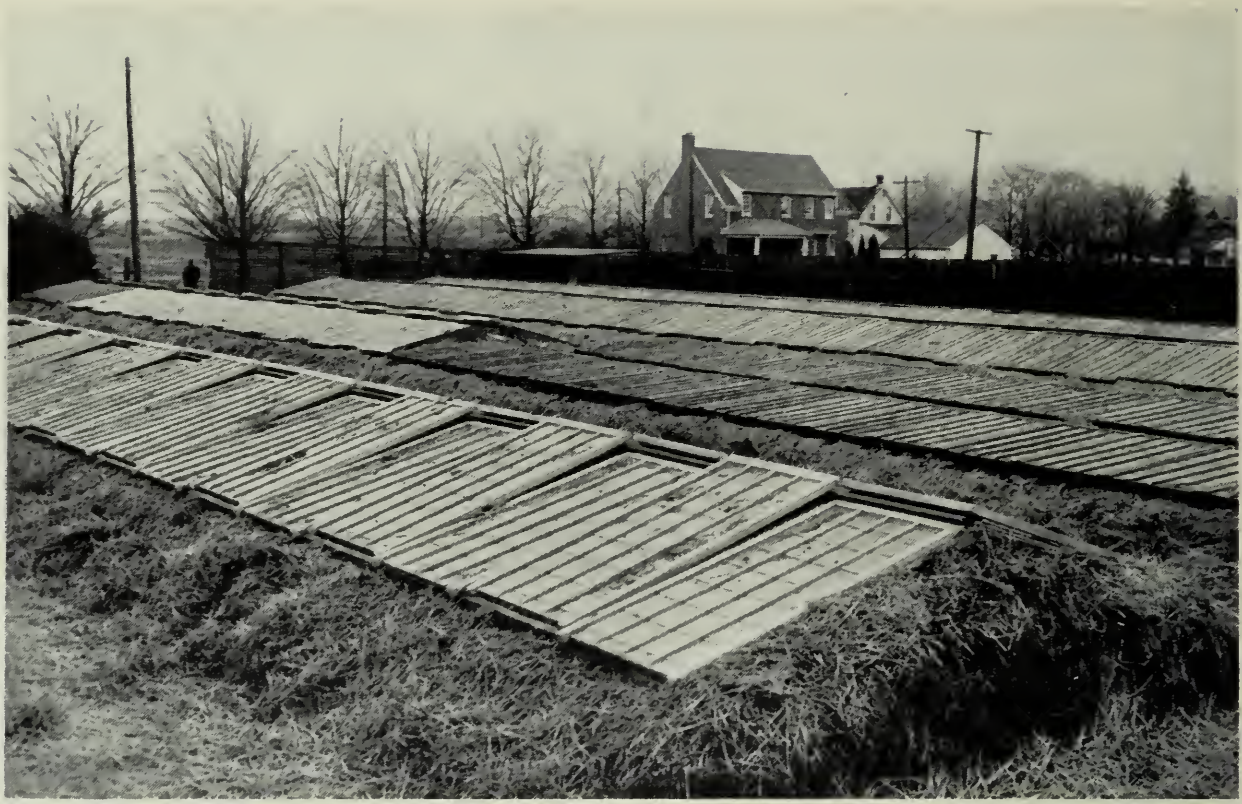


FIG. 4. Manure hotbeds.

THE MANURE-HEATED HOTBED

Fresh horse manure from grain-fed animals, preferably with the straw equal to about one-third of the total bulk, is used to generate the heat for the manure type of hotbed.

PREPARATION OF THE MANURE

Preparation of the manure begins about ten days before using the hotbed. The manure is piled about 5 feet high, about 6 feet wide, and the length required for the hotbed area. If the manure is dry, it is wise to sprinkle a small amount of water on it during the piling. To obtain uniform heating, it is necessary to turn the pile inside out when fermentation is progressing quite actively. When the pile is "steaming" throughout, it is suitable for hotbed heating.

PLACING THE MANURE IN THE HOTBED

The fermenting manure is placed on the well-drained site of the hotbed, and extends one foot beyond where the sides and ends of the frame will be. As each 6 inches of manure is added it is made firm by tramping.

In localities where the outdoor air temperatures do not go below 12° F. while the plants are in the frame, a layer of manure 12 to 16 inches deep is adequate if the outside of the frame is well banked with manure, and some type of covering, such as straw, is used on top of the glass throughout periods of low temperature. The depth of the manure should be increased 1 inch for each degree of lowered outdoor air temperature. Thus, about 24 to 28 inches of the manure are used for 0° F. outdoor temperature.

PLACING THE FRAME ON THE MANURE

The frame is placed on top of the fermenting manure. The glass sash is then placed between the sash bars. Additional manure is piled around the outside of the entire frame to aid in the retention of heat in the hotbed.

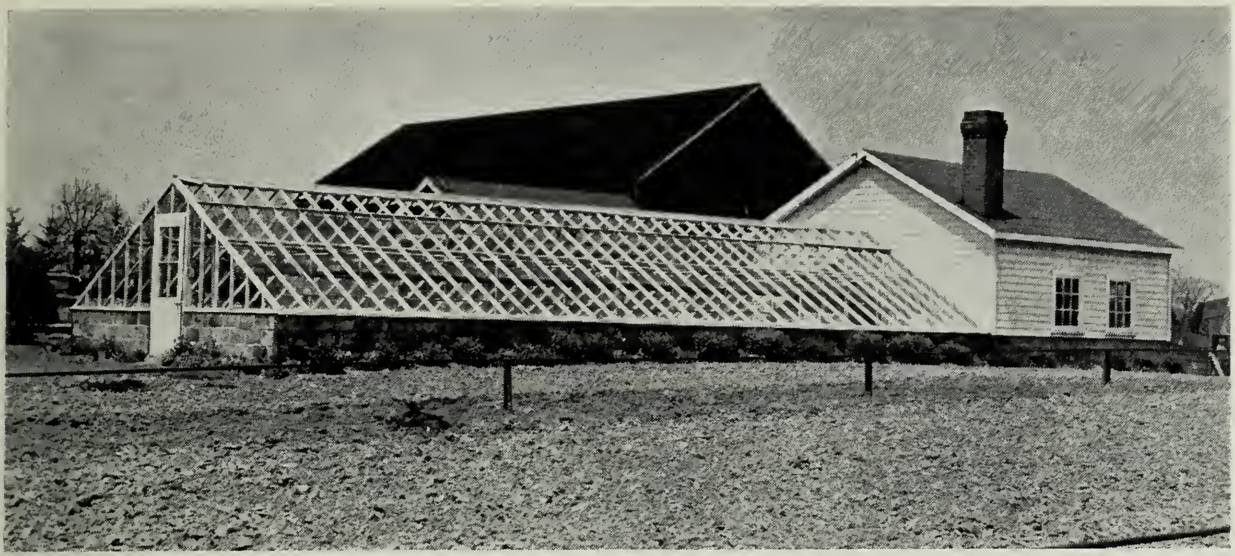


FIG. 5. Standard greenhouse. The roof consists of panes of glass. Ventilation is provided at each side of roof apex throughout entire length. Wooden benches are placed at each side and centre with a narrow passageway between centre and side bench. Flats with compost soil, containing germinating seeds or young plants are placed on the benches.

Placing the Compost Soil in the Hotbed

If seeding or planting is to be done directly in the seedbed, compost soil to the depth of 6 inches is placed on top of the manure inside the frame. When flats which contain compost soil are used, about 1 inch of any kind of soil is placed over the manure.

Time of Seeding and Planting

Seeding directly in the frame, or transplanting or moving seedlings there, is done when the temperature of the soil drops to 80° F. or slightly lower. Higher soil temperature may damage the seeds or the roots of the young plants.

THE HOT-WATER-HEATED HOTBED

With the single-sash frame, a 2-inch diameter, hot-water pipe is placed on the interior of the sides and ends of the frame. This pipe is slanted to permit the water to return to the heater by gravity. For the double-sash frame, the 2-inch diameter hot-water pipe is attached to the underside of the ridge pole and on the inside of each side of the frame.

STANDARD AND SASH GREENHOUSES

The sash greenhouse and the small standard greenhouse equipped with hot-water heating are much used as structures in which to germinate seeds and grow young plants to the first transplanting size or slightly longer. Then, when grown in large quantities, cucumber, eggplant, muskmelon, pepper, and tomato are placed in hotbeds until field-planting time because the cost of the hotbed is cheaper than that of the sash greenhouse or the small standard greenhouse. When produced in small quantities, the plants may be produced in the sash greenhouse, in the small standard greenhouse, or in the hotbed from seed-sowing to field-planting size. On the other hand, cabbage, cauliflower, and lettuce are usually moved into hotbeds for growth and to the coldframe for hardening prior to field planting.

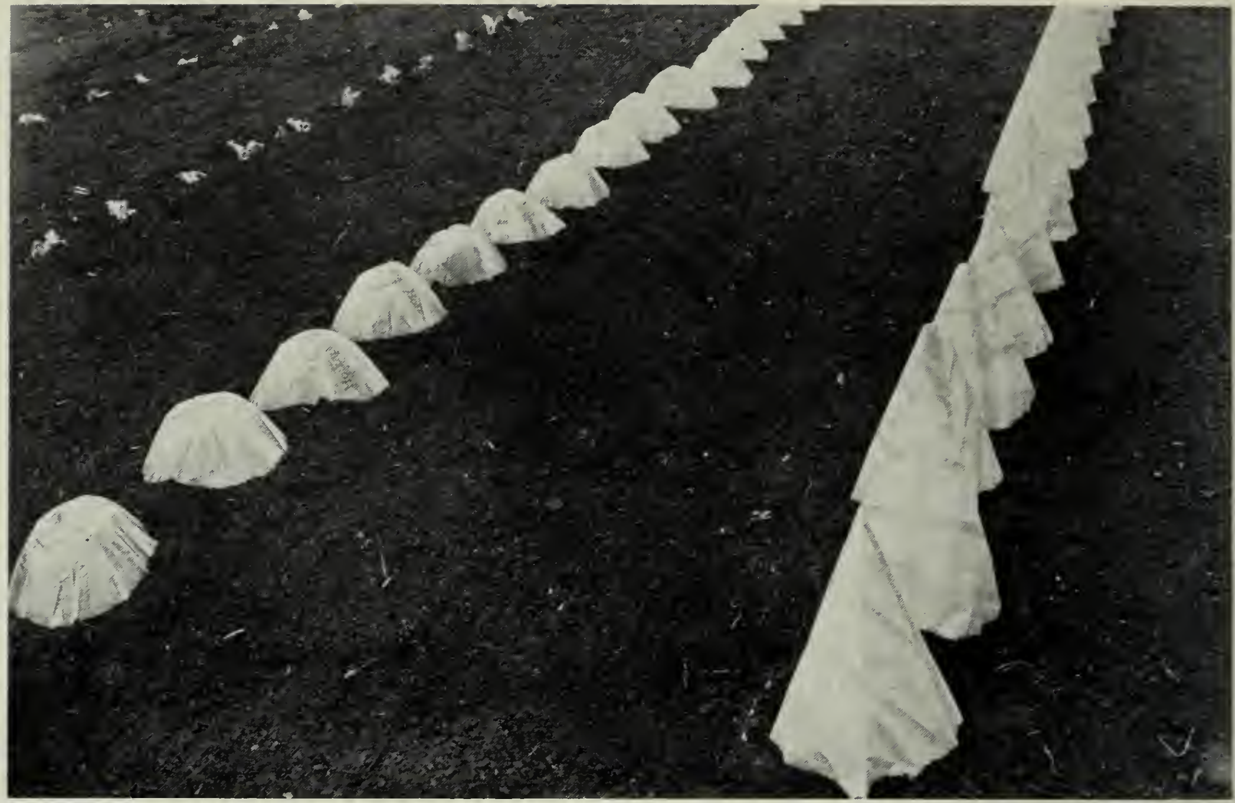


FIG. 6. Paper plant protectors.

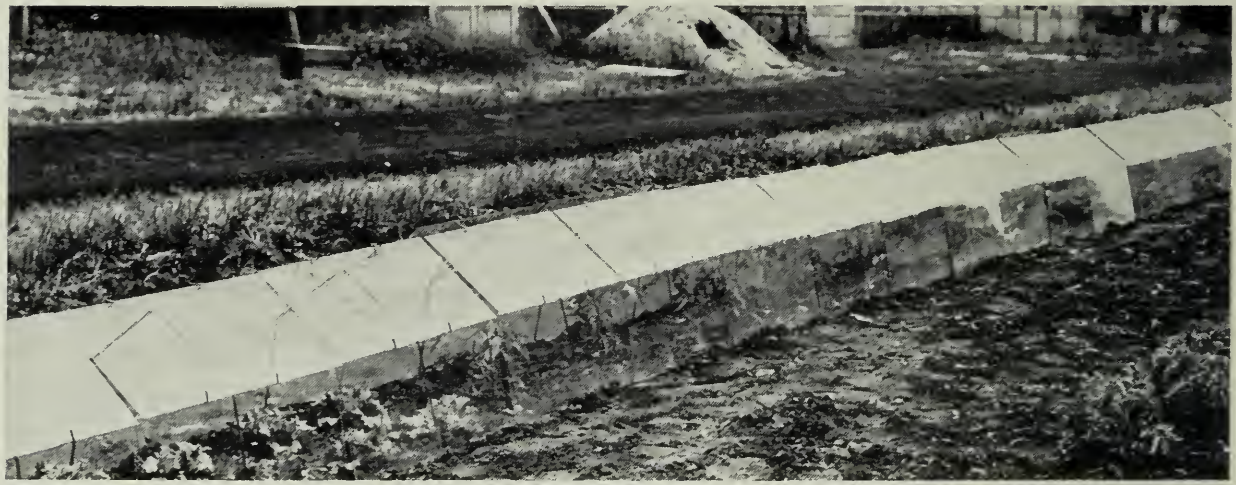


FIG. 7. A row of cloches. These miniature greenhouses provide protection against low temperatures for plants under them.

Compared with the manure-heated hotbed, sash- or standard-greenhouses are somewhat more expensive. But they provide a more constant air temperature, a more adequately controlled ventilation, and also an opportunity to transplant under cover at the proper stage of growth during inclement weather.

CLOCHES

Small-scale tests with cloches have been conducted at Guelph. Some types of these miniature greenhouses are so small that they can be picked up by hand and transported from place to place in the field. The tests have been carried out with early-sown or transplanted cucumber, head lettuce, cantaloupe, squash, sweet potato, tomato, sweet corn, and watermelon. The earlier harvest has been an advantage from the home-garden standpoint.

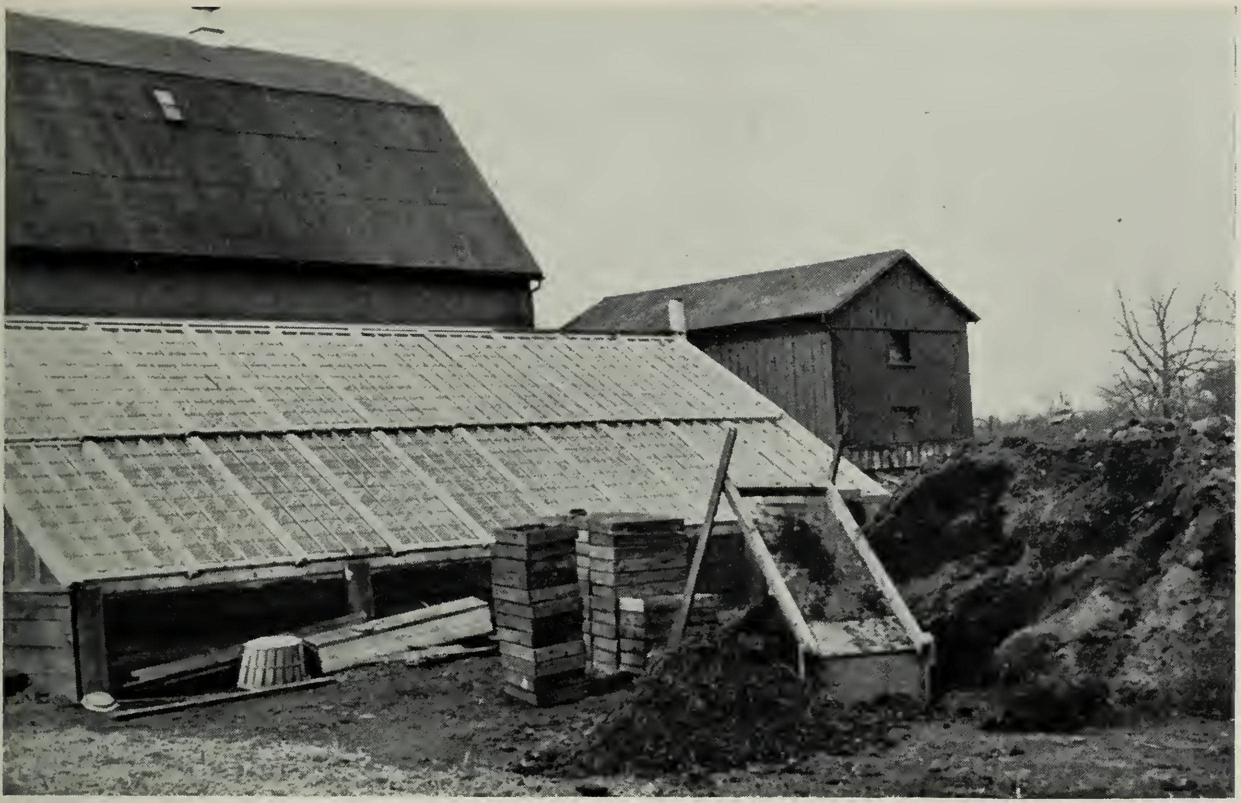


FIG. 8. Compost pile, screen for sifting the soil, and a small sash greenhouse.

PAPER PLANT PROTECTORS

Plant protectors usually consist of waxed and oiled papers and glassine paper of various types and are placed over the young plants of certain kinds of vegetables soon after transplanting. With the cantaloupe, in particular, efficient handling of plant protectors hastens early germination and growth, provides protection against frost in the field, and helps to avoid insect damage. For the same reasons, the protectors are sometimes placed over the young plants of cucumber, eggplant, pepper, and tomato.

To prevent the protectors from blowing away, and to retain heat, it is wise to place soil around their base. Also, it is necessary in hot weather to provide ventilation, so as to prevent excessive condensation or excessive heat, by making a small opening in the protector on the side opposite that of the prevailing wind. This opening is enlarged later as the air temperature permits.

SOIL

For the successful production of young vegetable plants, the soil in which they are to be grown must be carefully prepared. Ordinary soil, as it exists in gardens or fields, is usually not a satisfactory growing medium for use in seed-flats or beds, as it does not have the proper soil structure, water-holding capacity, and texture. Two methods of preparing soil for young plants are described.

Compost-Pile Method of Preparing Soil

A compost pile, which will be desirably high in organic matter, is constructed of alternate layers of sod and manure. The sod preferably should come from a sandy loam area, but sod from a light clay loam or silt loam can be used if necessary. Horse or strawy cow manures are the best for making compost. Pig or chicken manures are usually so high in nitrogen and total chemical salts that the young plant may suffer damage. The proportions of sod and manure should be 2 parts sod to 1 part manure.

The alternate layers of sod and manure should be built to a height of not more than 4 feet, not more than 5 feet wide, and with straight sides and ends. The length of the pile will depend on the amount of compost soil required. When placed in the pile each layer of manure should be firmed down and should be watered thoroughly to promote the decay of the straw in the manure. The top of the pile should be slightly concave or dished to catch water. If the compost soil is put through a soil-shredder before it is used, the manure and the soil will be blended and result in better physical condition.

The compost should be ready for use in one year's time. Its quality may improve if not used until a year or two later.

SOIL, PEAT, AND SAND MIXTURE

A widely used mixture for the medium in flats and beds is prepared by thoroughly mixing together, by volume, 7 parts of fertile sandy or light clay loam, 3 parts of horticultural peat, and 2 parts of sharp sand. The loam, peat and sand supply plant food, organic matter, and good aeration. The peat need not be sifted, but the sand or sandy loam should be sifted.

This mixture will not be as high in nutrient value as compost, and so subsequent feeding of the plants will be necessary. As most soils vary considerably in their chemical and biological makeup, it is difficult, if not impossible, to make fertilizer recommendations that will meet all the requirements. It is wise, therefore, to obtain a chemical analysis of the soil and to add fertilizers according to the results of the tests. A number of excellent "starter" solutions are avaliable for supplying nutrients to young plants.

STERILIZING AND DISINFECTING COMPOST SOIL

Steaming is an efficient method of sterilizing compost soil. It kills nematodes, weed seeds, and organisms that cause plant diseases.

Bench Method

Sterilization of the compost soil can be done in a greenhouse bench. The soil is placed to a depth of 2 inches on the bottom boards of the bench. Tiles (3-inch), properly fitted together, in rows 15 to 18 inches apart are used to conduct the steam. A useful measure of the proper distance between the ends of the adjoining tiles to allow the proper escape of steam is the thickness of the thin veneer of the fruit basket. The tiles are covered with about 12 inches of soil.

Perforated, 1- to 1½-inch, metal pipe may be used in place of tile. The perforations are made by drilling a straight row of ⅛-inch diameter holes which are 6 inches apart on directly opposite sides of the pipe. Place the pipes about 1 foot apart and also have the pipes 4 to 6 inches from each side of the bench.

Compost soil is placed to the depth of 12 inches above the pipes or tiles. The bed is covered with a tight-fitting tarpaulin or paper to prevent the escape of steam from the soil during sterilization.

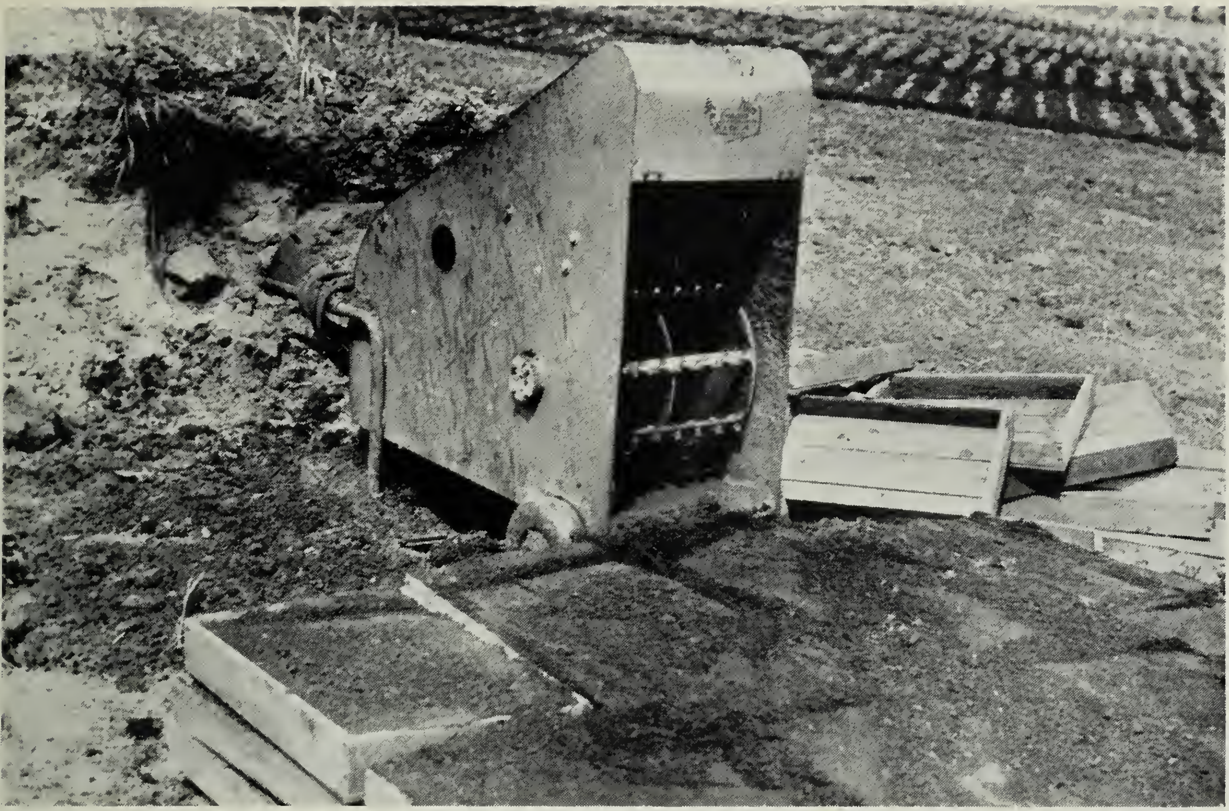


FIG. 9. A soil-shredder.

Box Method

A box of desired size, with tight sides and bottom, may be constructed for sterilization purposes. The previously described perforated metal pipes are placed on the bottom of the box, the pipes being kept 4 to 6 inches from each side, or, 3-inch tiles spaced in rows 15 to 18 inches apart may be used to conduct the steam. A tight-fitting tarpaulin is placed on the top of the box to retain the steam.

Temperature

Maintaining the soil temperature at 180° F. for 30 minutes is necessary for sterilization. A 220° F. thermometer is inserted to a depth of 4 inches midway between the rows of pipe or tile. Readings are taken at a number of places in order to be certain that all the soil is thoroughly heated.

Formalin

When steam sterilization is not possible, formalin or other disinfectants may be used. Formalin is a 40 per cent solution of formaldehyde gas in water. The soil should be made loose before adding the solution. Then, 1 gallon of formalin is poured into 40 gallons of water and the solution applied with a sprinkling can, at the rate of 2 quarts per square foot of soil. Following this application, the soil is covered for a day or two with a tarpaulin, bags, or papers which have been wet with the formalin solution to help keep the fumes in the soil. When the soil is sufficiently dry, it should be loosened again to permit the fumes to escape. Sowing of seed or setting plants should not be done within at least 10 days after treating the soil.

Other Chemicals

Certain chemicals, particularly chloropicrin and Dowfume MC-2, are being used, according to manufacturer's directions, with success in steriliz-

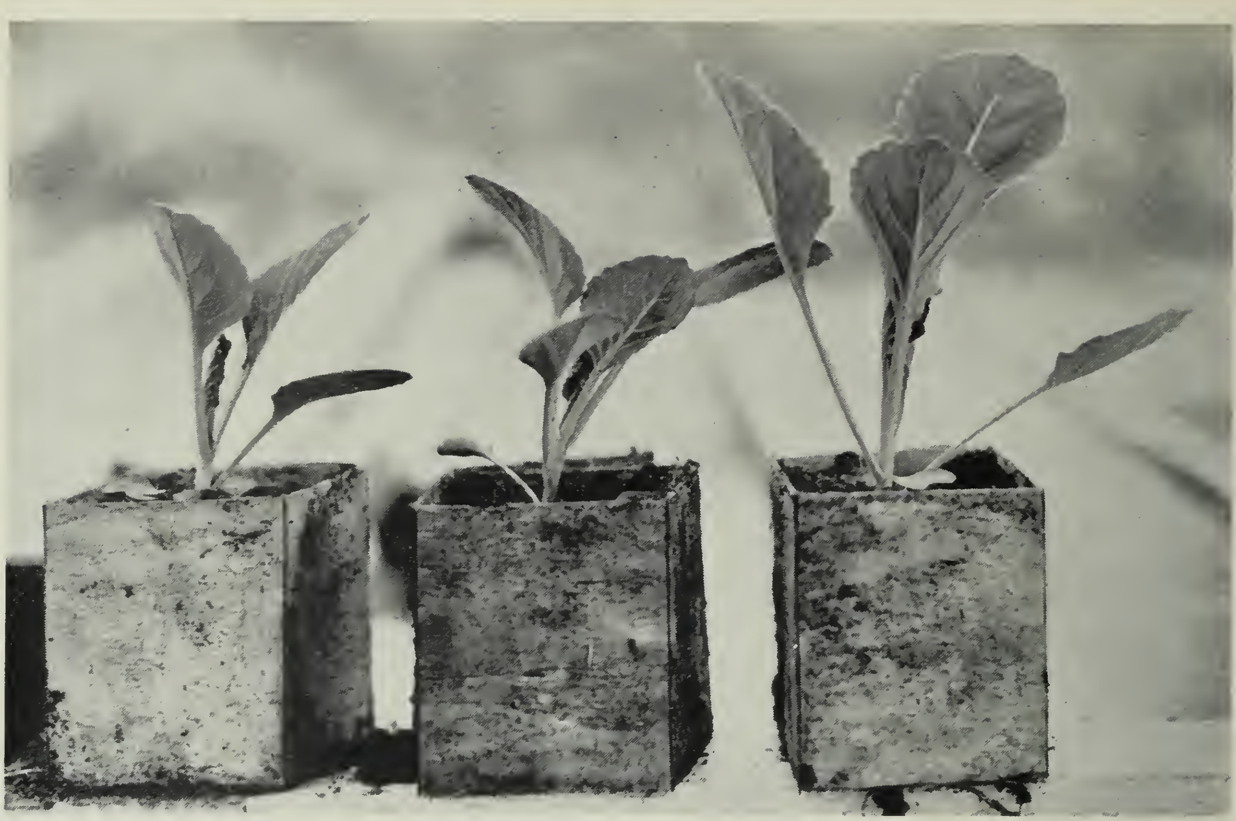


FIG. 10. Plant bands.

ing soil. With Dowfume MC-2, which is composed of methyl bromide and chloropicrin, the soil is frequently placed in flats which are piled to permit the movement of gas next to the soil.

PLANT CONTAINERS

The use of plant containers, e.g., wooden flats, clay pots, and plant bands, permits seed sowing and transplanting to be done under cover during inclement weather. These containers permit the easy transfer of the plants from the greenhouse or hotbed to the coldframe for hardening or from the coldframe to the field at the time of planting.

Wooden Flats

Wooden flats are much used for growing the young plants from seed sowing to the field planting stage.

Wooden flats vary considerably in size. The following measurements are used by many commercial growers: outside length 22 inches; length of each of two end boards, 12 inches; thickness of each end board, 5/8 inches; inside width, 12 inches; length of each side board, 22 inches; thickness of each side board, 3/8 inches; height of each side, 2¾ or 3 inches; outside width, 12¾ inches; thickness of bottom boards, 3/8 inches, with slight space between boards for necessary drainage.

Clay Pots

Ordinary clay pots are useful containers for single plants, but their initial cost and the labour involved in moving them is high, and their rapid drying out may be detrimental. Also they are easily broken.

Plant Bands

Wood veneer and paper plant bands of various sizes, without bottoms, are often used as containers for individual plants. When they are

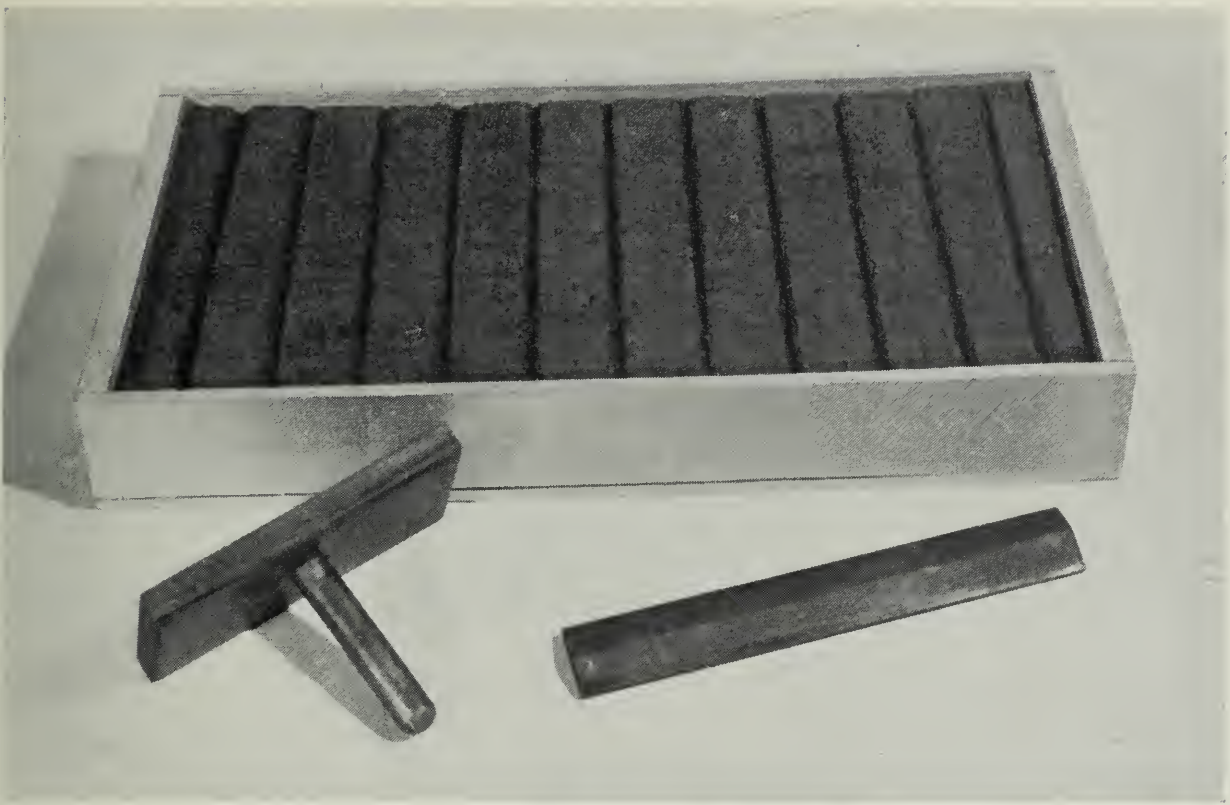


FIG. 11. Flat of compost soil prepared for seed sowing.

moved the soil is moistened sufficiently to maintain the soil in the plant band. These bands offer the advantage of little or no disturbance to the roots at field planting. They are often moved in flats from the greenhouse or sash-greenhouse to the hotbed, from greenhouse or sash-greenhouse to coldframe, or from hotbed to coldframe and to the field for planting. The bands are removed at planting time.

Soil Blocks

Small blocks of compressed compost may be used instead of pots. If the blocks are properly made, they will possess some merit over the ordinary pot. However, the operator must be experienced in preparing the compost and handling the machine. If the blocks are not properly made they will either be too loose and fall apart, or be too compact and thereby prevent adequate aeration. Even more than usual care must also be exercised in the watering of these blocks. There are a number of machines on the market for making soil blocks.

PLACING COMPOST SOIL IN THE FLAT

For vegetable-seed sowing, the flat is filled two-thirds full with compost soil, prepared as previously described. On top of this soil, finer compost, which has been sifted through a ¼-inch sieve, is placed as follows: fill the flat above the rim; with the fingers, firm the corners and sides; with a straight-edge, level the soil; with a tamper, tamp the soil level so that its surface is ¼ to ½ inch below the rim to provide the necessary water space.

For young plants to be transplanted, good procedure is as follows: fill the entire flat, above the rim, with lump-free compost soil; with the fingers, firm the corners and sides; with a straight-edge, level the soil even with the rim; then, tamp the soil level so that it is ¼ to ½ inch below the rim for the necessary water space.

VEGETABLE SEED TREATMENTS

It is wise to treat most vegetable seeds previous to sowing. The annual Vegetable Protection Calendar provides up-to-date information concerning the materials which should be applied to each kind of seed.

GROWTH OF YOUNG PLANTS AFTER TRANSPLANTING

The nature and condition of the roots of the various kinds of young vegetable plants are significant in recovery from transplanting. At least three important factors are involved, namely: the proportion of the root system retained in transplanting; the effectiveness of the retained roots in absorbing water from the soil during the first few days after transplanting, which is an effect correlated with the amount of suberin in the roots; and, the rate of new root formation.

Suberin consists of a cellulose chemically combined with compounds of a fatty or waxlike nature which renders the cell walls of the roots impervious to water. Three groups, based on the suberin condition may be arranged as follows:

Group 1. This group includes plants of cabbage, lettuce, and tomato, which easily survive transplanting. New roots are formed quickly and a significantly small amount of suberin is present in the roots, thus permitting an efficient absorption of water.

Group 2. The young plants of celery, onion, and pepper do not produce new roots quickly during the first few days after transplanting. They are moderately easily transplanted. The suberin content in the roots of these plants is greater than in the roots of the plants of Group 1.

Group 3. Subsequent to transplanting, cucumber and muskmelon plants produce, in the same time of growth, a smaller amount of roots than do the young plants of Groups 1 and 2. They do not grow well with the ordinary method of transplanting. Roots of the cucumber and muskmelon possess more suberin than do the roots of the plants in the two previous groups, and hence the roots absorb less water. A special method, which is described later, is used when the cucumber and the muskmelon are transplanted.

HARDENING YOUNG VEGETABLE PLANTS

There are three common commercial methods of hardening: (a) subjecting the plants to cool air temperature, meanwhile maintaining ample soil moisture; (b) keeping the soil moisture just sufficient to maintain growth, meanwhile providing the optimum air temperature for growth; (c) combining just sufficient soil moisture and relatively low air temperature to maintain growth. These methods are started one week to ten days before transplanting to the field.

Hardening enables the young plants to better withstand drying soil, winds, and hot sunshine during the first few days immediately after field planting. Also, it imparts greater frost-resistance to certain vegetable plants, such as cabbage and lettuce. Specific hardening methods are given later for the different kinds of vegetable plants.

PLANT PRODUCTION

The best methods of plant production and of seed sowing in the field vary with different vegetable crops. The more important of these crops are discussed separately.

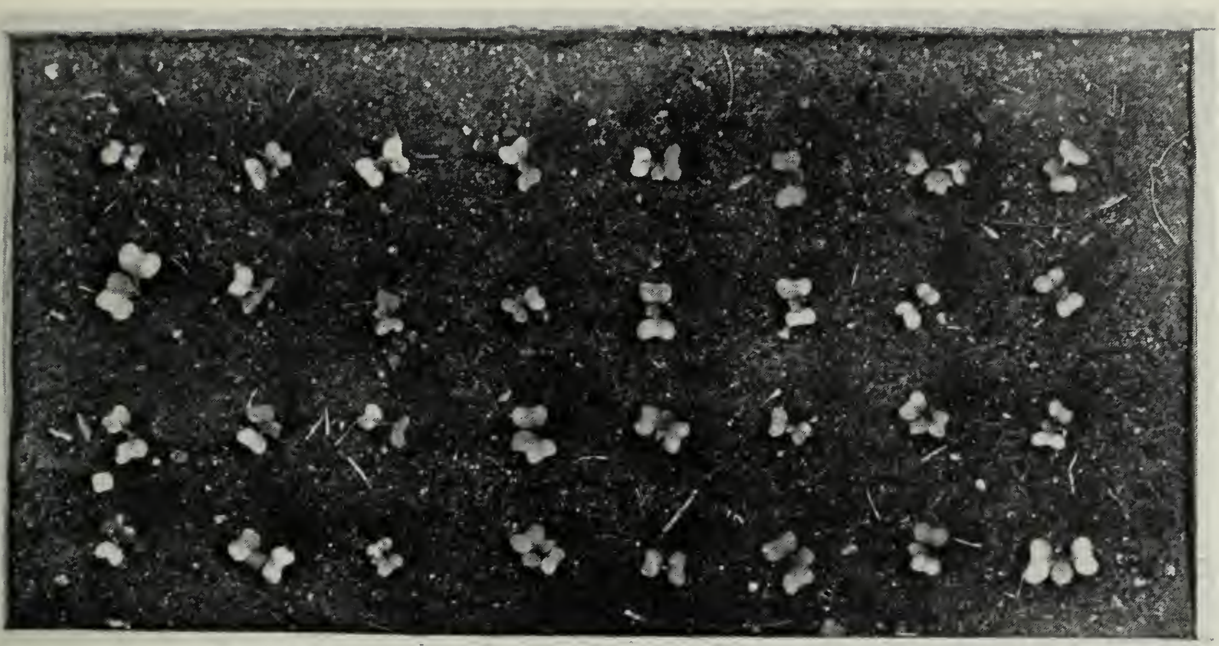


FIG. 12. First transplanting of cabbage plants.

CABBAGE PLANTS

There are a number of methods of growing young plants for the early and late cabbage crops. Only the chief methods are discussed here. About 4 ounces of seed should produce enough plants to set an acre of cabbage.

Early Crop

For early cabbage, seed of an early variety is sown 6 to 7 weeks before transplanting outdoors. A fertile compost soil is used.

The seed is sown in a flat in a hotbed or greenhouse, in a raised bench in a greenhouse, or directly in a hotbed. Sowing is done ¼-inch deep, in rows 2 inches apart, and at the rate of about 10 seeds per inch (there are about 7,500 cabbage seeds in an ounce). Moderate soil moisture and an air temperature of 65° to 70° F., preferably 70° F., help to promote optimum germination. During the interval between seedling emergence and the first transplanting an air temperature of 55° to 60° F. and a constant, moderate soil moisture should be maintained so far as possible.

The first transplanting is done when the first true leaf is about ½ inch long. This amount of leaf development indicates the presence of an adequate amount of root system for satisfactory transplanting. At this stage of growth the plant is moved into compost soil in a 2½- by 2½-inch plant band or in a 3-inch clay pot, or into a flat at a spacing of 2½ by 2½ inches. These containers are usually placed in a hotbed where a minimum night air temperature of 50° F. and a day temperature of 55° to 60° F., with moderate soil-moisture conditions, are provided until the commencement of hardening-off under the cooler conditions of a coldframe. When set in the garden the plant should possess three or four well-developed true leaves and an ample amount of roots.

A significant degree of frost resistance is imparted to cabbage plants by hardening-off for about 10 days before setting in the garden. The day after planting in the field, properly hardened young cabbage plants should show little or no wilting, whereas non-hardened plants may have wilted severely. A well-hardened young cabbage plant, produced by supplying soil

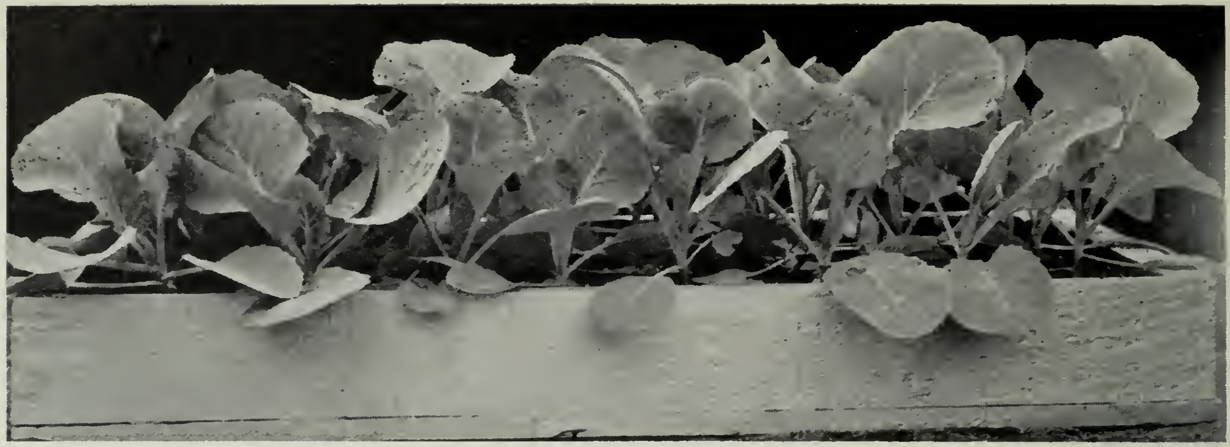


FIG. 13. Early-crop cabbage plants in flat ready for field planting.

in which it grew with just sufficient water to maintain slow growth and an air temperature of 50° F. to 55° F., is not likely to be injured when exposed to 25° F. outdoor air temperature for 2½ hours.

Late Crop

For a late cabbage crop, seed of a late variety is sown in a well-prepared, moderately fertile, outdoor seedbed about 6 weeks prior to transplanting in the field. Seed is sown ½ inch deep, in rows 14 to 16 inches apart, and at the rate of about 8 seeds per inch. When the plants reach the three or four true-leaf size they are transplanted during the first week in July to the field where they will mature.

BRUSSELS SPROUTS PLANTS

Plants for the early and late crops of Brussels sprouts are grown in the same manner as outlined for cauliflower.

SPROUTING BROCCOLI PLANTS

Early varieties of sprouting broccoli reach marketable maturity in 70 to 75 days from the date of setting the young plants in the field. Plant production is similar to that outlined for cauliflower.

CAULIFLOWER PLANTS

Cauliflower plants are more difficult to grow than those of cabbage. The growth of the young cauliflower plant must be continuous, and the plant must not be too tender or too hard at field-planting time. About 4 ounces of seed should produce enough plants to set an acre of cauliflower.

Early Crop

For the early cauliflower crop, seed of an early variety is sown ¼ inch deep, in rows 2 to 2½ inches apart, and at the rate of about 8 seeds per inch under glass in compost soil. Seeding is done directly in a hotbed, or in flats in a hotbed or greenhouse, about 7 weeks before transplanting in the field. Seed germination is helped by moderate soil moisture and an air temperature of 70° F.

After the emergence of the seedlings and until the first transplanting, a moderate soil moisture and an air temperature of about 60° F. are

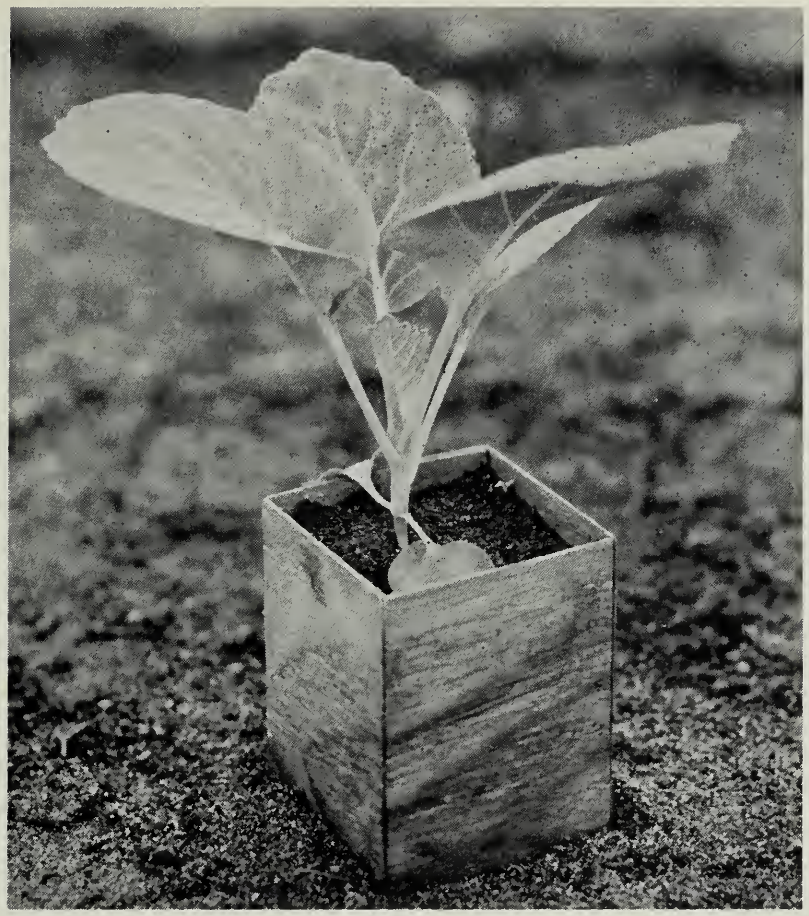


FIG. 14. Early-crop cabbage plant in plant band ready for field planting.

provided. When the first true leaf is about ½-inch long, transplanting is done into compost soil in a flat at 2½ by 2½ inches spacing, or into a 3-inch clay pot, or into a 2½- by 2½-inch plant band. The young plants are placed in a hotbed. A minimum of night air temperature of 55° F., and a day temperature of 55° to 60° F., preferably 60° F., are maintained from the first transplanting to the stage of hardening-off. Then the plants are placed in a coldframe.

Well-hardened young cauliflower plants are slightly more susceptible to damage from frost than cabbage plants. At transplanting time they should have three or four well-developed true leaves and a plentiful supply of roots.

Hardening should not be conducted under too cold or too dry conditions and the growth should not be seriously checked because such hardening significantly reduces both early yields and total yields.

Late Crop

About 6 weeks before the plants are to be set in the field, seed of a late cauliflower variety is sown ½-inch deep in rows 14 to 16 inches apart in an outdoor seedbed of fertile soil. About 8 seeds are sown per inch. Transplanting to the location where the crop is to be produced is done when the plants reach the three or four true-leaf stage.

CELERY PLANTS

Celery seed is not sown in the field where the crop is grown to maturity. A transplanting method is always practised. About 4 ounces of seed should produce enough plants to set an acre of celery.

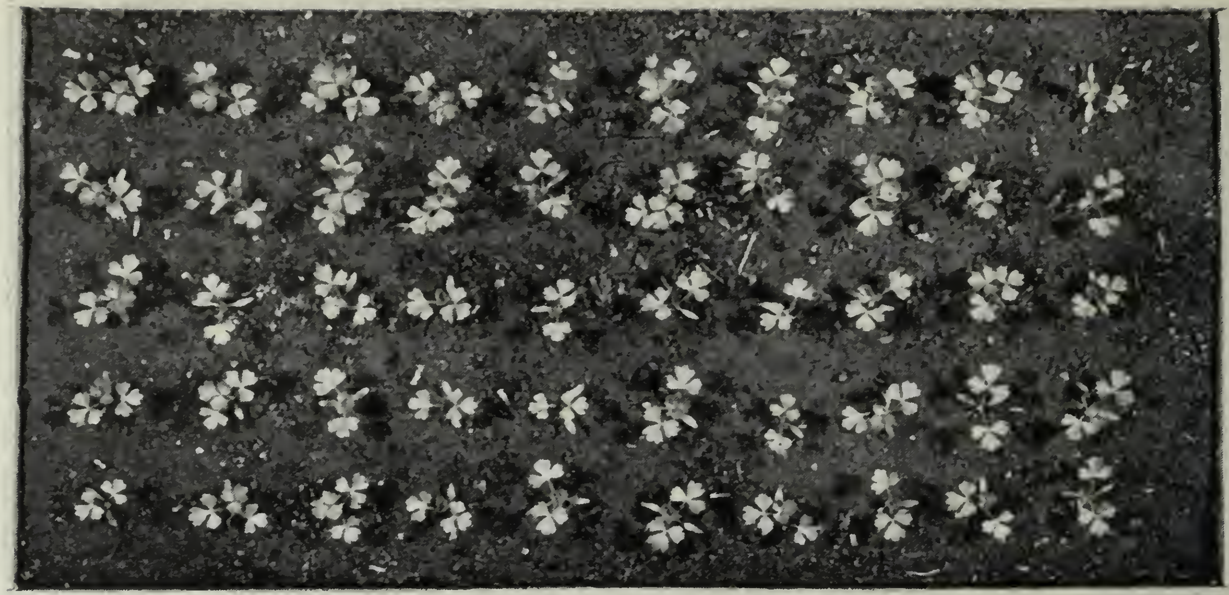


FIG. 15. Good stage for first transplanting of celery.

Early Crop

For the early celery crop, seed is sown approximately ⅛ inch deep in fertile compost soil 10 weeks before transplanting in the field. There are some 75,000 celery seeds in an ounce. About 20 seeds per inch are sown in rows 2 to 3 inches apart.

The young plants are commonly produced in flats, or directly, in the hotbed. They may be grown in a raised bench or in flats in a greenhouse.

An air temperature of 70° to 75° F. is maintained during germination and until the plants emerge through the soil. From then until the time of field planting, day air temperatures of 60° to 65° F., and a minimum night temperature of 60° F. are good.

The first transplanting is done when two or three true leaves have developed. The seedlings are spaced 2 by 2 inches apart in compost soil. Constant soil moisture is maintained throughout growth until the hardening-off period. Then the maintenance of a low moisture content in the soil and an air temperature of 60° to 65° F. for about 10 days previous to planting in the field is probably the best method of hardening-off these plants. The plants are set in the field when four true-leaves have developed.

At the Holland-Bradford marsh, seed for the early crop is sown in peat soil in the greenhouse. The plants are transplanted at the third true-leaf stage to peat soil in a coldframe, where they are left to grow to field-planting size.

Late Crop

For the late celery crop at the Holland-Bradford marsh, the seed is sown during the first ten days of May in an outdoor raised bed of peat. The seed is either broadcast or is sown with the garden seed drill in rows 6 inches apart. Transplanting in the field is done when the plants have developed five or six true leaves. No previous transplanting is practised.

In the Thedford area, seed for the late crop is broadcast during the last two weeks in April in a finely prepared, field muck-soil location. Transplanting is done directly from the seedbed to the field.

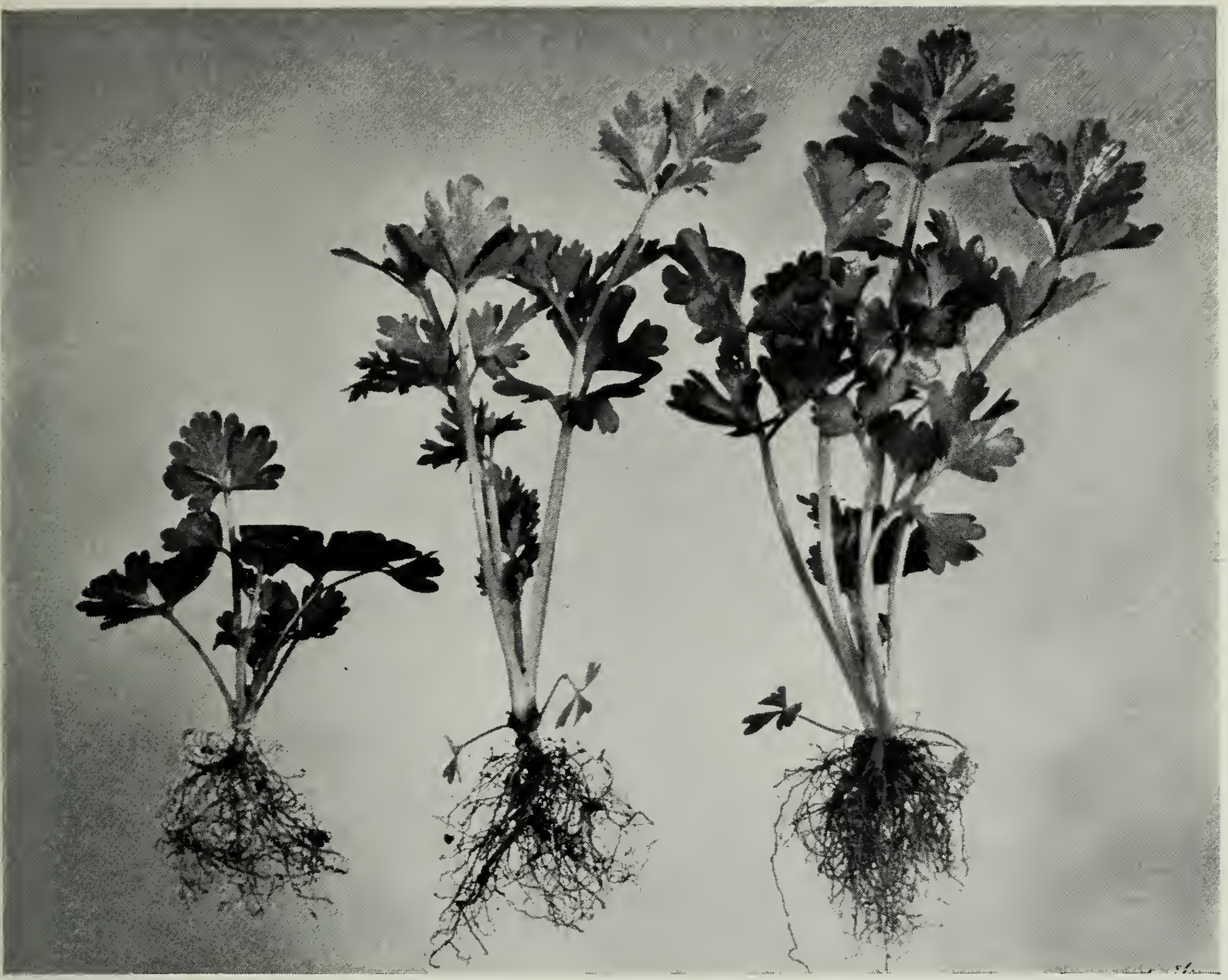


FIG. 16. Celery plants for field planting. The plant at the left possesses suitable leaf and root but the other two plants have developed too much leaf for best success.

In sand-loam and clay-loam areas, seed is sown about 10 weeks before field transplanting time in compost soil in hotbeds or coldframes. Temperatures similar to those mentioned for the production of the young plants for the early crop are suitable. One transplanting at the two or three true-leaf stage is usually done.

Premature Seeding

When young celery plants are grown in an air temperature of from 40° to 60° F. for 15 to 30 days much premature seeding or bolting often occurs later in the field when the air temperature is 60° F. or higher. When the young plants are grown in air temperatures of above 60° F. prior to field planting few seedstalks are produced when the field air temperatures are 60° F. or higher. Thus it is better to harden-off young celery plants by withholding water than by exposing them to a cool temperature.

Eggplant Plants

Eggplant seedlings for planting in the field are usually produced in a greenhouse or hotbed. About 10 weeks prior to field-planting time, 10 seeds per inch are sown $\frac{1}{4}$ inch deep in rows 2 to 3 inches apart; 6 ounces of seed will produce enough plants for an acre. Good germination temperature is 70° to 75° F., and it must not be lower than 65° F. From the time of seedling emergence until transplanting in the field, the preferred tem-

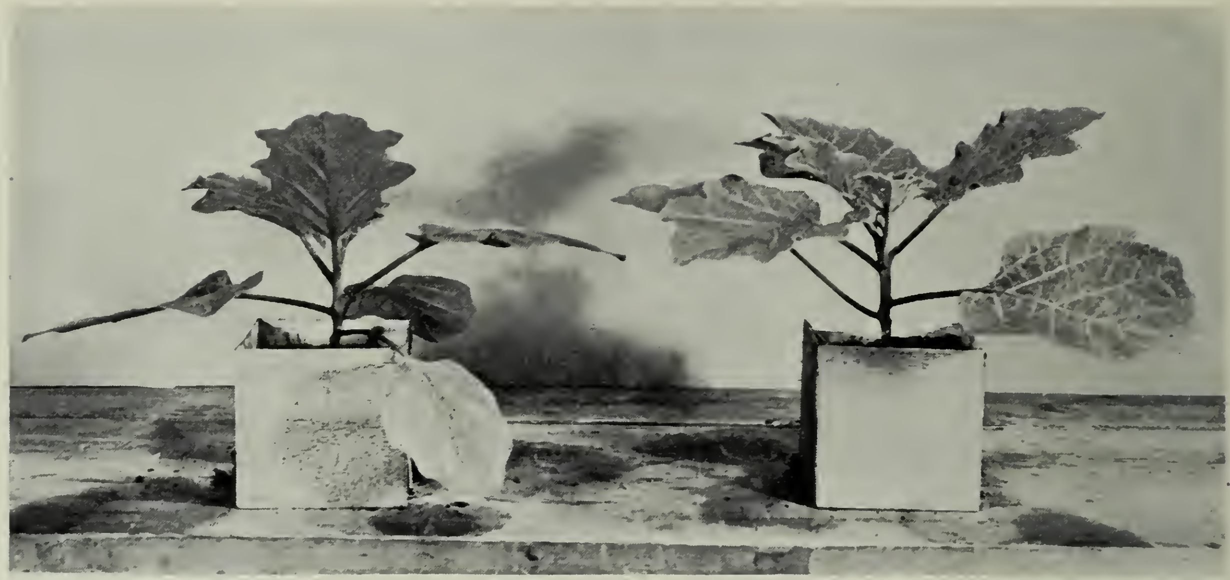


FIG. 17. Eggplant in plant bands ready for field planting.

perature range is 70° to 80° F., although 65° to 75° F. is satisfactory. The growth of the plants must not be checked or yield will suffer.

The only transplanting of eggplant is done when the first true leaf is small. The young plant is then moved into compost soil in a 4- by 4-inch plant band or a 4-inch clay pot, where it grows until field-planting time. Sufficient watering is done to maintain moderate soil-moisture conditions.

Throughout the week or ten days previous to field planting, it is wise to maintain air temperatures of 65° to 75° F. and reduce the soil-moisture supply. This hardening does not impart to the plant any significant frost resistance, but it does provide some resistance against wilting during the first few days after planting in the field. At the time of transplanting the plants should have developed four true leaves.

LETTUCE PLANTS

The early lettuce crop is produced by transplanting methods, and requires 2 to 3 pounds of seed for enough plants to set an acre. The late crop is grown by direct seeding. When mechanical seeders are used, about 2 pounds of seed per acre are commonly sown but under favourable conditions 1 pound may suffice.

Early Crop

To grow plants for the early, outdoor, head-lettuce crop, seed is sown about 8 weeks before transplanting in the field. A fertile compost soil is used in the plant-growing structure as described for cabbage. Sowing is done in rows 2 inches apart at a depth of ¼ inch, with approximately 15 seeds per inch; there are some 26,000 seeds per ounce. Air temperatures for germination, growth of plants, and hardening are like those mentioned for cabbage.

The seedlings are transplanted when the first true leaf is small, the plants being placed 2 by 2 inches apart into compost soil in flats in a hotbed. Or, the plants may be grown directly in the hotbed soil. By field-planting time, 3 or 4 leaves that are one-fourth to one-third grown should be present on the plants. The plants are hardened-off, during the 10 days before transplanting, by one of the methods previously described.

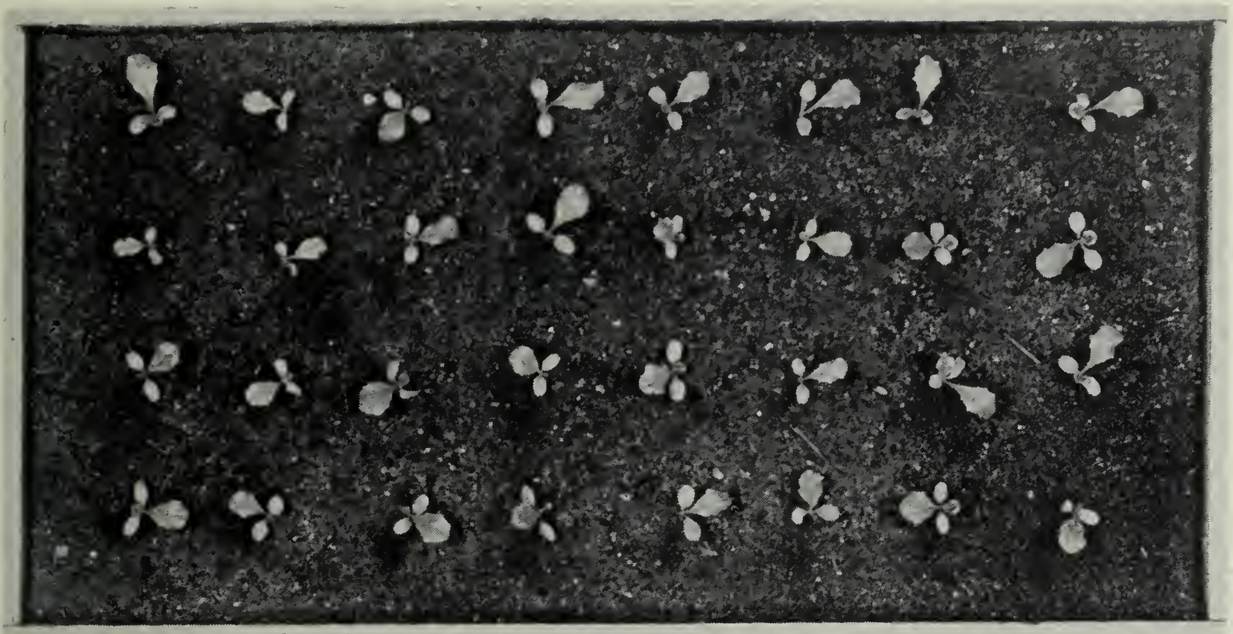


FIG. 18. Early-crop lettuce plants ready for the first transplanting.

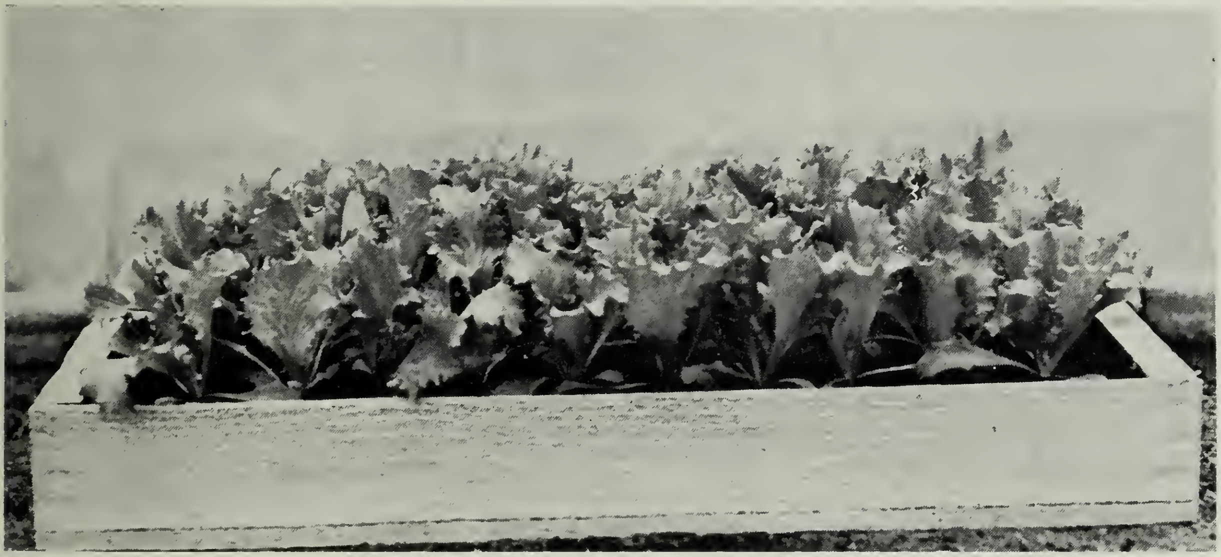


FIG. 19. Early-crop lettuce plants ready for field planting.

Late Crop

For the late crop, the seed of head lettuce is sown during the first two weeks in July directly in the soil on the site where the crop will mature. The plants are thinned, at the first true-leaf stage, to 12 inches apart in the row.

MUSKMELON PLANTS

The muskmelon plant is quite tender to frost. The plants are difficult to transplant successfully for an early crop, and so a special procedure is described.

Early Crop

The plants for the early muskmelon crop are commonly started in hotbeds or greenhouses. About 5 weeks before transplanting outdoors 3 seeds are sown 1 inch deep in (a) fertile sand-loam sods, 3 by 4 inches square and 2 to 3 inches deep, or (b) in fertile compost soil in 4- by 4-inch

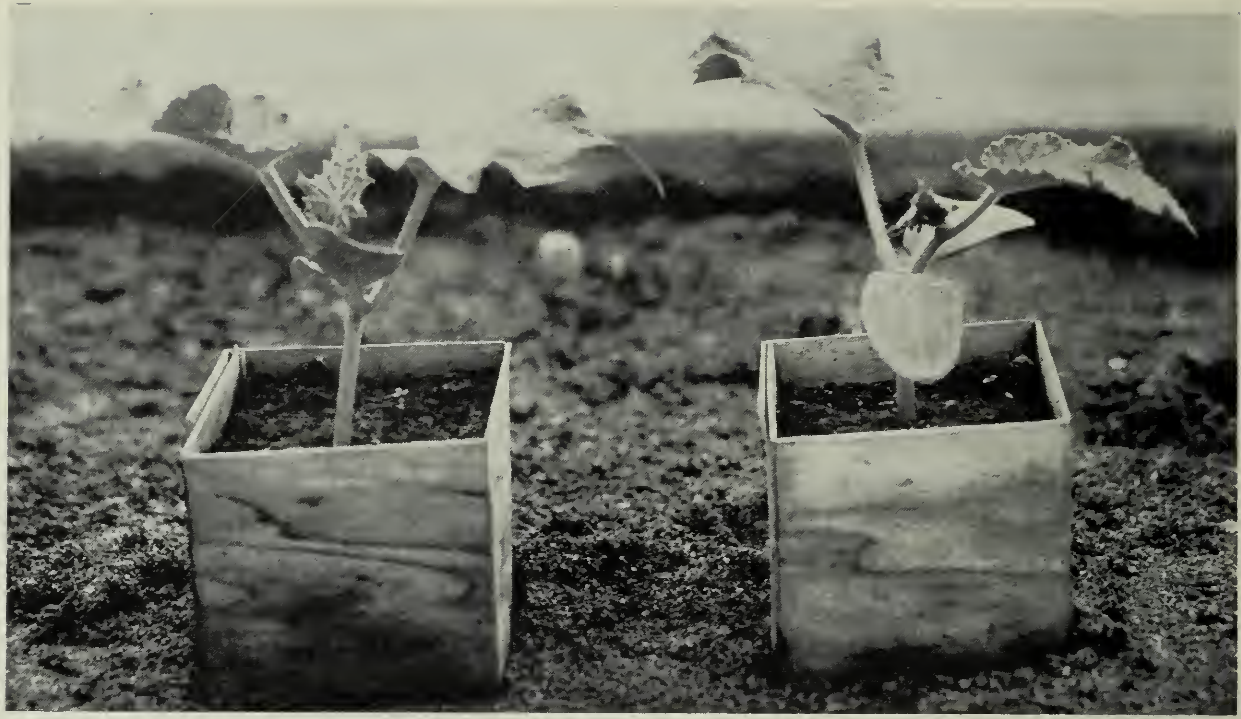


FIG. 20. Cucurbit plants in plant bands.

plant bands or 4-inch clay pots. Very soon after the emergence of the plants through the sod or compost soil the seedlings are reduced to two in each unit. Those to be eliminated are removed by cutting the stem with a knife. These two plants remain in this sod, or in the plant bands or clay pots, until set in the field. Then the sod or compost soil, containing all the roots of the two plants, is covered shallowly with field soil.

Good air temperatures for seed germination are 70° to 75° F. From the time of emergence of the seedlings until the plants are set in the field, night air temperatures should be 60° to 65° F. Good day air temperatures are 70° to 75° F. during sunny weather, but not exceeding 70° F. during cloudy weather.

Late Crop

The seed for the late muskmelon crop is sown ½ to 1 inch deep in hills or drills in warm soil in the field after all danger of frost is over. Sowing is done at the rate of 8 to 12 seeds per hill, or 2 to 3 inches apart in rows about 6 feet apart. Either method requires approximately 3 pounds of seed per acre. When the first true leaf is slightly developed, the plants are thinned to two per hill, or to a spacing of 2 feet between the plants in the row.

ONION PLANTS

The Spanish type of onion is usually grown by the transplanting method. The seed is sown ⅛ to ½ inch deep, either broadcast or in rows 3 to 4 inches apart, in compost soil in flats in a greenhouse or hotbed, about 10 weeks before transplanting in the field.

Good air temperatures for seed germination are 60° to 65° F. Then an air temperature of 60° F. should be maintained, so far as possible. It is usually wise to harden the seedlings before transplanting. The hardening may be done by withholding water, by exposing the seedlings to cooler

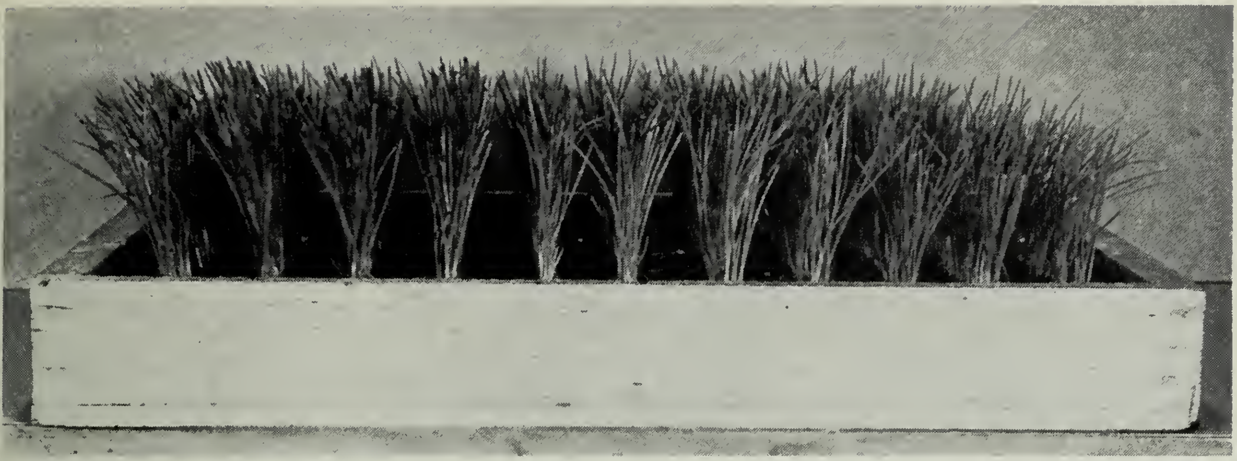


FIG. 21. Spanish onion plants at a good stage for transplanting to the field.

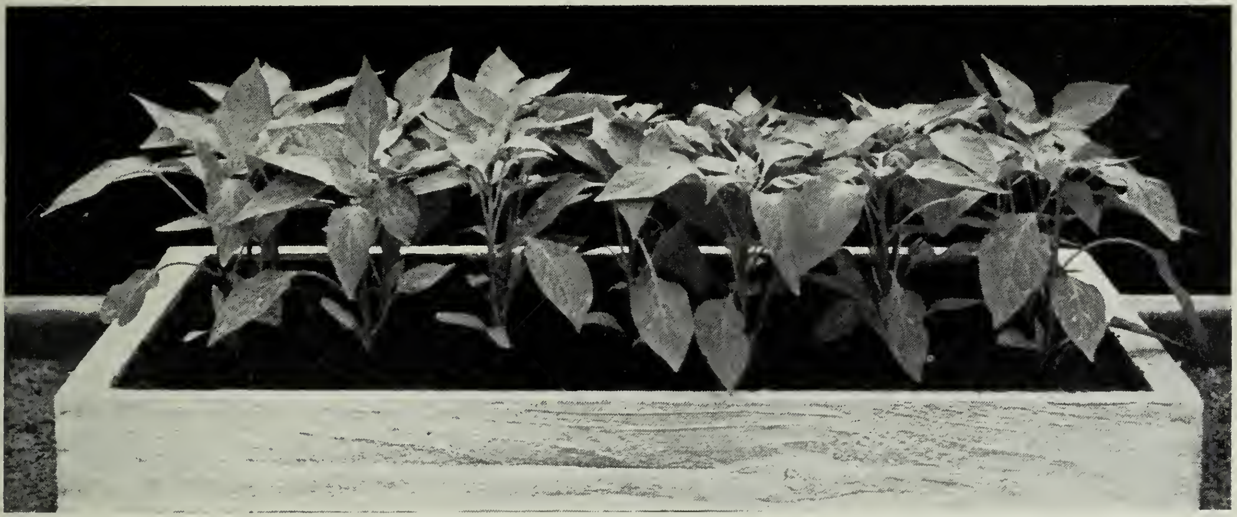


FIG. 22. Pepper plants at field planting time.

temperature for about one week, or by both methods. A good plan is to water the seedlings less frequently and to expose them to night temperatures of 40° to 45° F. for a week or 10 days before transplanting.

Commencing when the young plants are about 5 inches high and continuing until field planting, weekly clipping back to a uniform height of 4 to 6 inches is done to promote stocky stems. A suitable size of stem at the transplanting stage is about half the thickness of a lead pencil. Planting outdoors is done as early as weather and soil conditions permit.

PEPPER PLANTS

A fertile compost soil is used for growing pepper plants. The plants may be grown in a raised bench of the greenhouse, in a flat in a greenhouse or hotbed, or directly in the hotbed.

Nine to 10 weeks before transplanting to the field, 10 seeds are sown per inch in rows 2 inches apart. An ounce of pepper seeds contains 4,500 seeds and 8 ounces will provide enough plants for an acre. Good air temperatures for germination are 70° to 75° F., and subsequently, until hardening-off, 60° to 70° F.

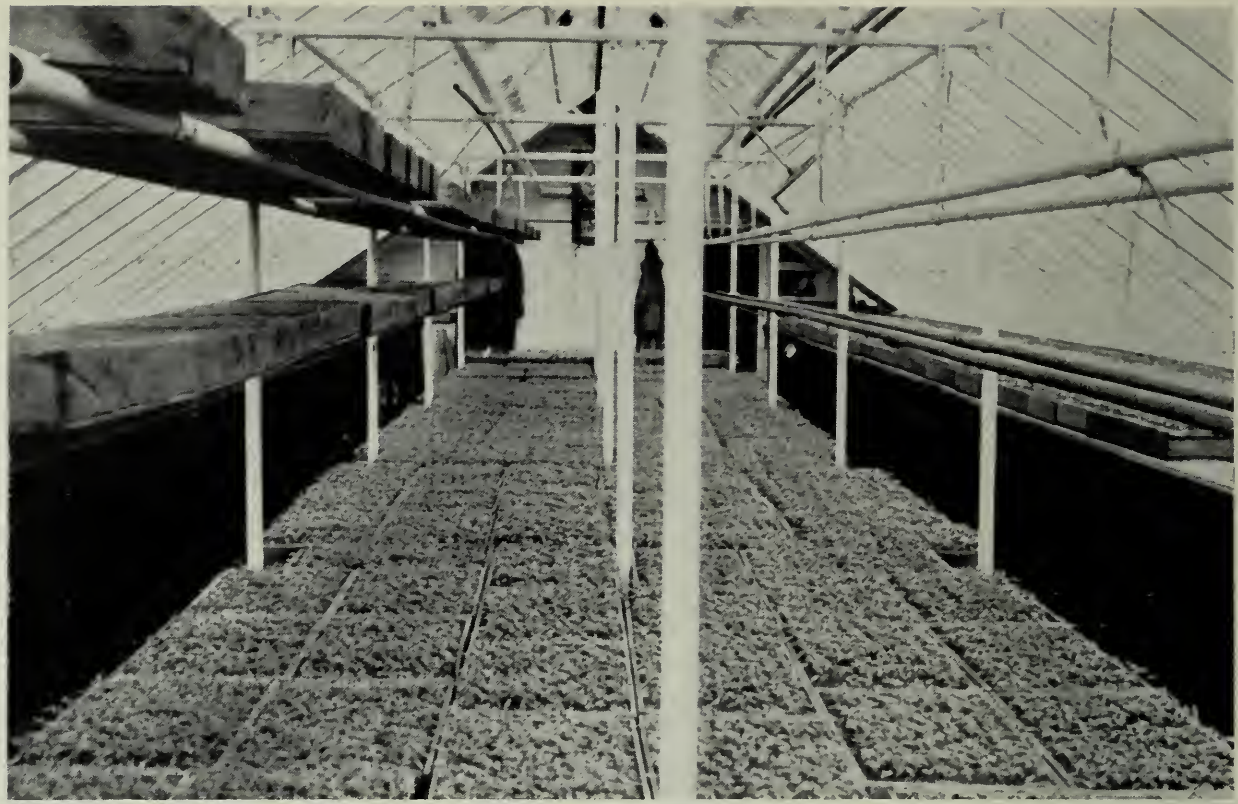


FIG. 23. Tomato plants in flats in a greenhouse.

The only transplanting of pepper is done when the first true leaf is about ½ inch long. The plants are spaced 2½ by 2½ inches, or 2 by 2½ inches apart.

Hardening provides resistance to wilting but no significant resistance to frost. The hardening of pepper plants is helped by decreasing the soil-moisture supply and maintaining day air temperatures of 55° to 60° F. with a night temperature of 55° F. throughout the week previous to planting in the field.

Transplanting in the field is done after the danger of frost and severe cold winds is past. The plants should then be 6 to 7 inches high.

TOMATO PLANTS*

From 3 to 4 ounces of seed should produce enough plants to set an acre of tomatoes. There are about 10,000 tomato seeds in an ounce.

Early Outdoor Crop

Nine to 10 weeks before the time of planting in the field the seed is sown in fertile compost soil at the rate of 10 to 12 seeds per inch in rows 2 inches apart. The seed sowing, in compost soil, may be done in a raised bench, in flats in a standard or sash-greenhouse, or in a hotbed.

Good germination temperature is 70° to 75° F. Desirable subsequent air temperatures are 60° to 70° F. during the day, and a minimum of 60° F. at night.

When the first true leaf is ¼ to ½ inch long and there is an adequate root system, transplanting is done to space the plants 2 by 2 inches apart

---

* Further information is available in Ontario Department of Agriculture Bulletin 464, "Tomato Plants for the Processing Industry."

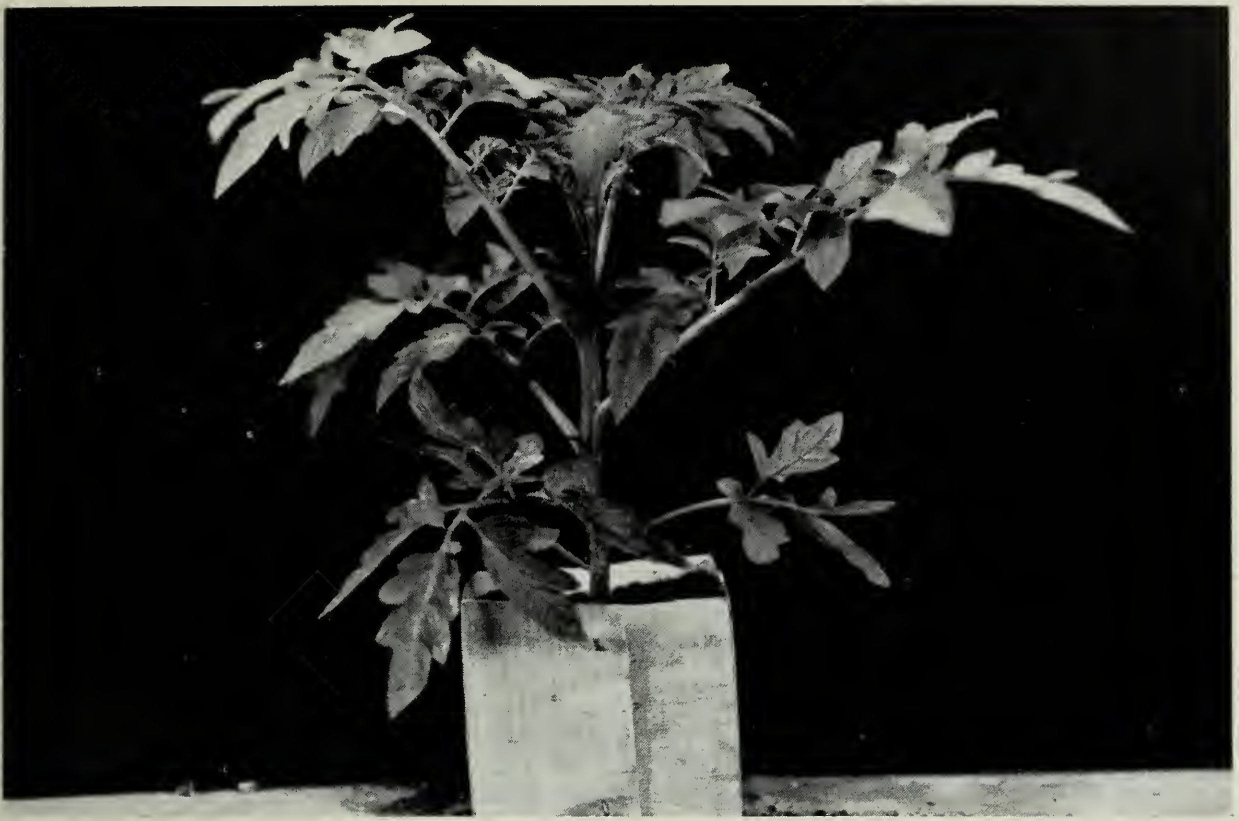


FIG. 24. Early-crop tomato in plant band ready for field planting.

in compost soil in flats. These flats are usually placed in a hotbed, but they may be placed in a standard or sash-greenhouse.

A second transplanting is done when the leaves of the plants touch or slightly overlap and a well-developed root system is present. In this operation the plants are placed in compost soil: (a) 4 by 4 inches apart in flats, usually in a hotbed; (b) in the 6 inches of hotbed soil; (c) in 3½- or 4-inch clay pots; or (d) in 3- by 3-inch or 4- by 4-inch plant bands, commonly in a hotbed.

Common procedure for hardening is to keep the soil just moist enough to maintain growth, and to provide 60° F. air temperature. The young tomato plant cannot, like cabbage, be made appreciably resistant to frost. Severe hardening, as with cabbage, should not be attempted. However, comparatively high potash content in the composted soil seems to promote hardiness in tomato plants.

At field-planting time, the tomato plants should possess a stocky, and firm but not hard stem, and a well-developed healthy root system. There should be buds on the first blossom cluster. Preferably, these buds should not have commenced to open, because sometimes the check in growth in transplanting to the field causes the fully opened blossom cluster to fall off the plant.

Late Crop

Seed for the late tomato crop is sown about 7 weeks before transplanting to the field. The seed is placed in compost soil in a flat, or raised bench in a greenhouse, in rows 2 inches apart, at the rate of 10 to 12 seeds per inch. Or, the seed may be sown directly in the hotbed.

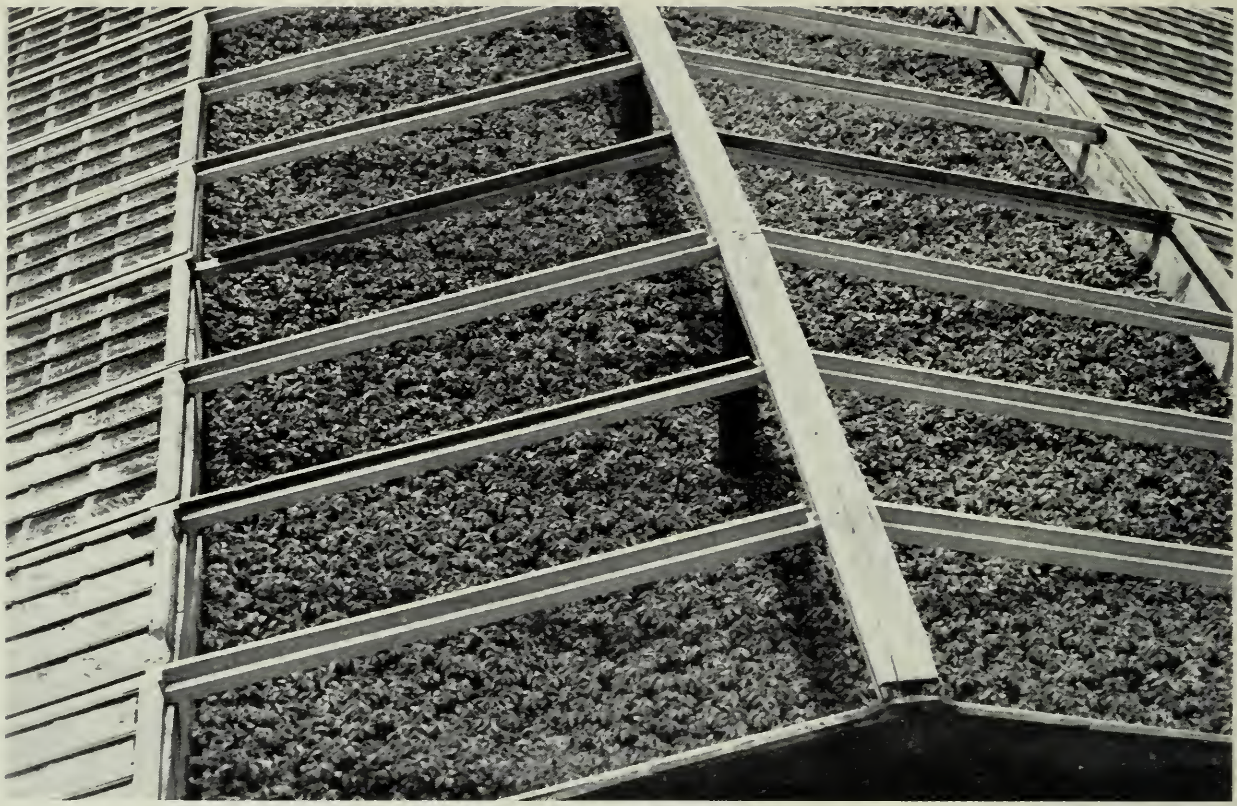


FIG. 25. Tomato plants in a double-sash hotbed.

Good temperature for germination is 70° to 75° F. Subsequently, day air temperatures of 60° to 70° F. and a minimum night air temperature of 60° F. are maintained.

When the first true leaf is ¼ to ½ inch long, transplanting is done to space the plants 2 by 2 inches apart in compost soil in flats. The common practice is to grow the plants to the field-planting size in these flats in a hotbed.

About 10 days before transplanting to the field, that is, when the plants are 6 to 8 inches high, the soil moisture is kept just sufficient to maintain growth, and a 60° F. air temperature is provided, in the hotbed. If the plants are placed in a coldframe a moderate soil moisture and a 55° F. air temperature are furnished. This provides some resistance to wilting and resistance to perhaps one degree of frost.

Southern-Grown Plants

Young tomato plants raised in the southern part of the United States are successfully used by some Ontario growers who specialize in canning crops. The canners import these plants in large lots and distribute them to the grower.

These tomato plants are produced outdoors on specially prepared soil where they attain suitable root, stem, and leaf development for field planting and shipment. They are pulled when about 8 inches high, placed in bundles of about 50, packed in moist moss, wrapped in paper, and shipped in hampers or crates.

The best southern-grown are produced from certified seed which has been chemically treated. Later, these young plants are sprayed.

BULLETIN 486

APRIL, 1952

ONIONS

•

ONTARIO AGRICULTURAL COLLEGE
GUELPH ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

Page
INTRODUCTION 5
AREAS OF PRODUCTION 5
  Mature-Bulb Crop 5
  Dry Sets 5
  Green-Bunch Onions 5
  Sweet Spanish Type 8
ORIGIN AND DEVELOPMENT 8
PLANT CHARACTERISTICS 9
  Germination and Seedling Development 9
  Roots 10
  Leaves and Stems 10
  Bulb 10
CLIMATE 12
  Temperature 12
  Length of Day 12
  Moisture 12
SOIL 12
  Soil Reaction 13
  Influence of Previous Crops 13
  Soil Preparation 14
MANURE AND FERTILIZER 15
  Farmyard Manure 15
  Green Manure 15
  Nitrogen 15
  Phosphorus 16
  Potassium 16
  Copper 16
  Manganese 17
  Magnesium 17
  Fertilizer Recommendations 18
SEED 18
MATURE ONIONS GROWN FROM SEED 18
  Cost of Production 18
  Sowing Time 19
  Sowing Rates 19
  Spacing 20
  Depth of Sowing 20
  Seeding Equipment 20
  Varieties 21
PRODUCTION OF DRY-ONION SETS 21
  Culture 21
  Harvesting 21
  Grading 22
  Varieties 23

CONTENTS — Continued

Page

ONIONS GROWN FROM SETS 23
Cost of Production 23
Planting Time 23
Planting Methods 23
Depth of Planting 23
Spacing 24
Planting Rate 24

ONIONS GROWN FOR PICKLERS 24

ONIONS GROWN FROM TRANSPLANTS 24
Seed Sowing 24
Trimming 25
Hardening 25
Transplanting 25
Varieties 26

ONIONS GROWN FOR GREEN BUNCHING 27
Bunch Onions from Sets 27
Bunch Onions from Seed 27
Egyptian or Perennial Tree Onion 27
Non-Bulb-Forming Type 28
Multiplier or Potato Onion 28
Shallot 28
Greenhouse Forcing of Storage Bulbs 28

CULTIVATION AND WEED CONTROL 29
Hand Weeding 29
Chemical Weed Control 32
CALCIUM CYANAMID 32
STODDARD SOLVENT 33
POTASSIUM CYANATE 33
SULPHURIC ACID 34

IRRIGATION 34

HARVESTING 34
Ripening and Maturity 34
Pulling 35
Curing 35
Topping 38
Grading 38
Storage 38
TEMPERATURE 39
HUMIDITY 39
SPROUT INHIBITORS 39
STRUCTURES 40

INSECT AND DISEASE CONTROL 40

ONIONS

by

C. C. Filman and J. S. Shoemaker

Department of Horticulture, Ontario Agricultural College, Guelph, Ontario

INTRODUCTION

The onion crop is one of the most important vegetable crops grown in Ontario. Onions, in the immature and mature stages, are consumed throughout most of the year.

Characteristic flavour is an outstanding feature which accounts for the popularity of onions. Onions provide an appealing flavour when prepared in various ways as a fresh vegetable. They are much used for pickling. Onions are also very useful for frying, boiling, baking, soup making, and other purposes. The expression "smothered in onions" emphasizes the importance of this vegetable in the art of cooking.

AREAS OF PRODUCTION

Mature-Bulb Crop

Production of the mature-bulb crop of onions in Ontario has changed, in the past 10 to 15 years, from widespread small-scale production to areas of concentrated large-scale production. Commercial production is now confined chiefly to four main growing areas, namely, the Holland-Bradford marshes, the Leamington marsh, the Jeanettes Creek and Dover marshes, and the Erieau marsh.

The high real-estate value of some of the older onion-producing areas on mineral soils, as well as the competition from organic soil areas, have largely been responsible for the shift in production from mineral to muck soils. However, onions can be grown in almost all parts of the Province on nearly all types of soil, except possibly the very light sands, provided suitable varieties are selected and the soil is properly prepared.

Dry Sets

About 30 percent of the dry sets used to produce the early mature-bulb crop, as well as green bunch onions, are grown in Ontario. Thedford is the largest dry-set-producing area. It averages around 120 acres, and a production of 300, fifty-pound bags per acre per year. The remainder of the Ontario requirements is met by importations from other provinces, chiefly Manitoba and Quebec, and from the United States.

Green-Bunch Onions

Green-bunch onions are produced in a number of different ways. The more important ways are from seed sown directly into the soil outdoors, from dry sets, and from matured storage bulbs that are forced in the greenhouse.

Green-bunch onions are grown in almost every market garden and home garden. Some of the larger producing sections are: the LaSalle and River Canard

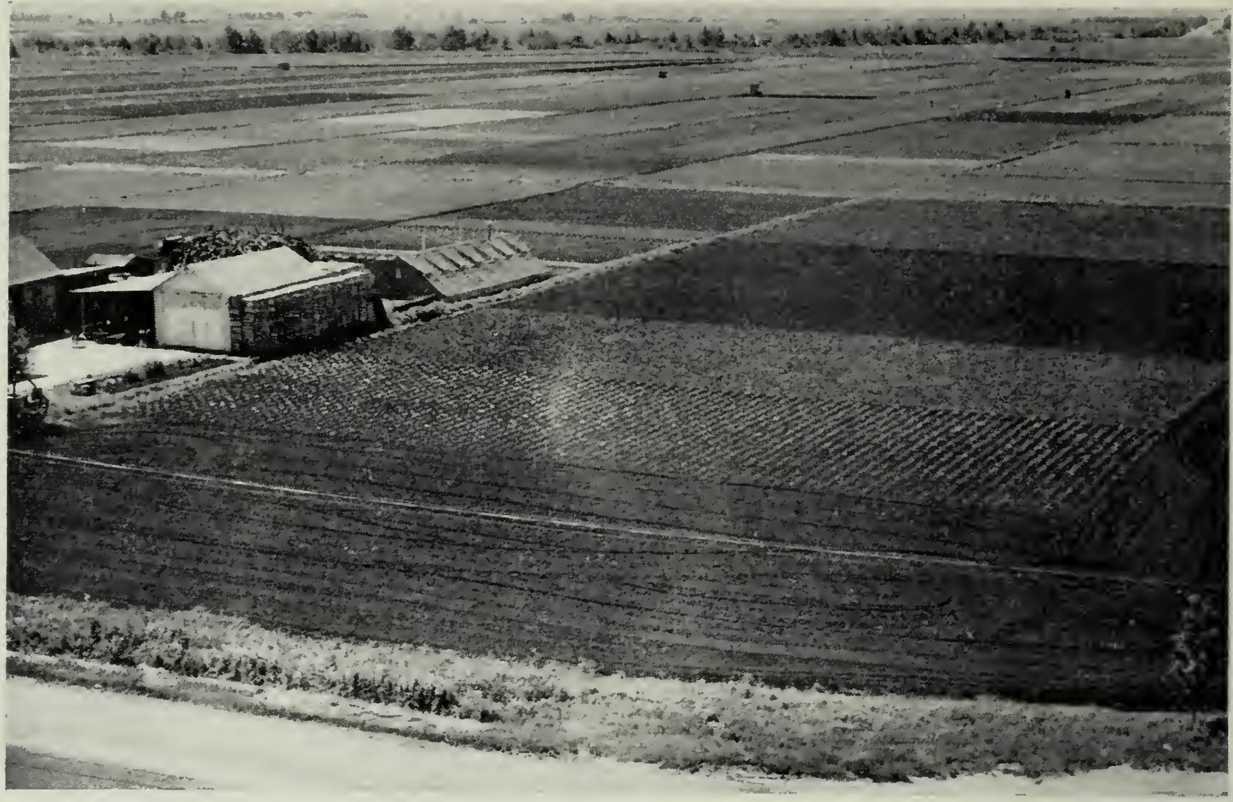


FIG. 1. A view of the Holland-Bradford marshes.

FIG. 2. A fine field of onions growing on the Erieau marsh for storage purposes.

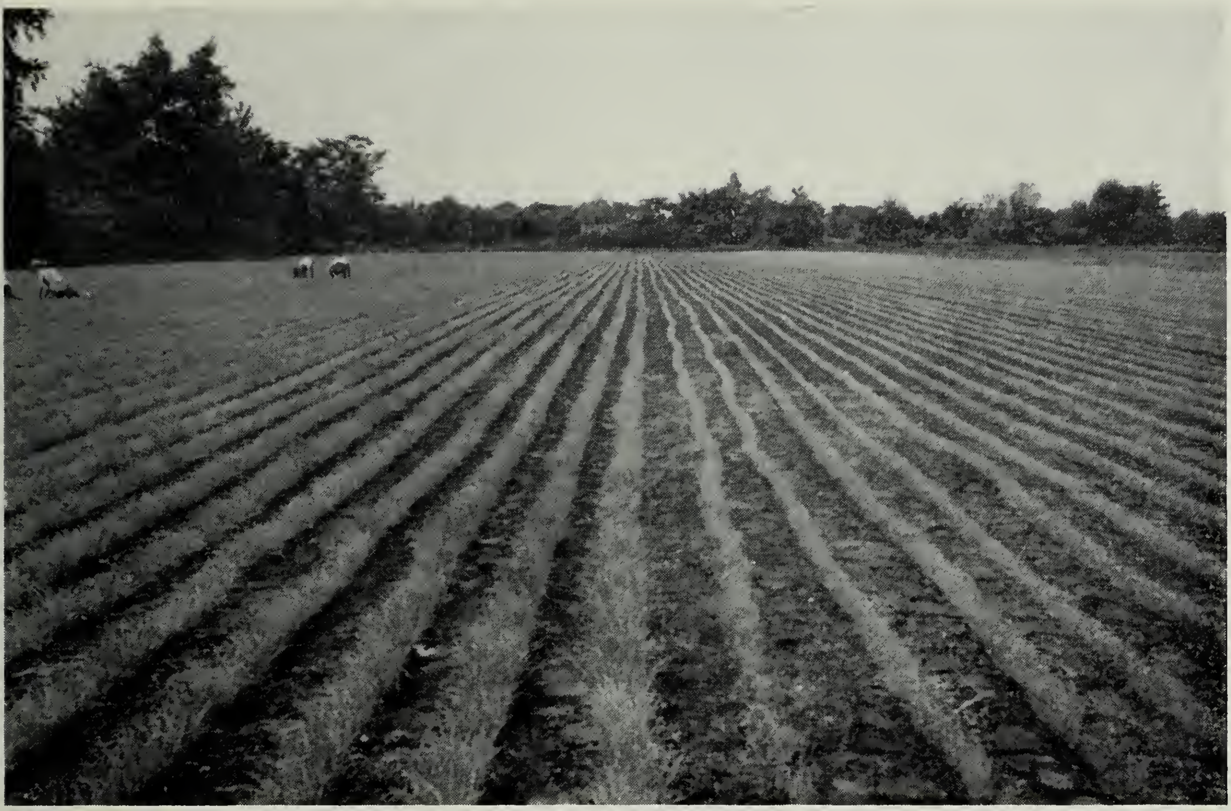


FIG. 3. Producing onion sets on the Thedford marsh.

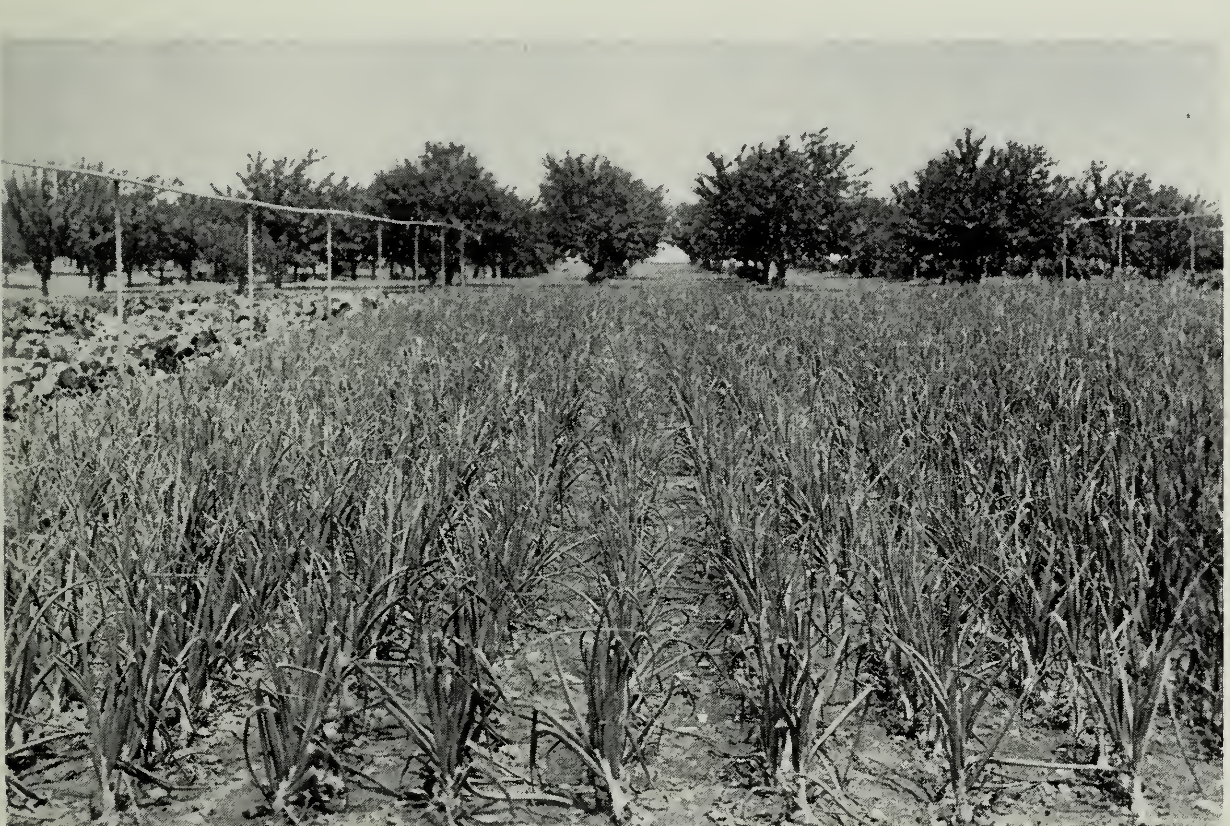


FIG. 4. Onions growing under irrigation on a mineral soil. (Vineland).

areas near Windsor; and the Toronto area which includes, Scarborough, Agincourt, Unionville, Humber Bay, Islington, Dixie, Cooksville, Weston, Woodbridge, Nashville, Hornby and Norval. On marsh land, green-bunch onions are a minor crop.

Sweet Spanish Type

Most of the commercial production of the Sweet Spanish type of onion occurs on mineral soils near local markets throughout the province. Sweet Spanish onions are a minor crop on the marsh areas because of the long growing season required, the high cost of raising seedlings indoors and transplanting to the field, and the adaptability of other vegetables to large-scale production.

The acreage of Sweet Spanish type of onion, near local markets, has increased considerably in the past few years. This is partly due to the introduction of hybrids that are more productive and uniform than the older varieties.

ACREAGE AND PRODUCTION OF ONIONS ON MARSH LAND

Crop	Year	Leamington *Acres*	Erieau *Acres*	Jeanettes Creek and Dover Marsh *Acres*	Thedford *Acres*	Bradford *Acres*	Total Acreage *Acres*	Av. Yield per Acre *50-lb. Bags*
Mature bulbs from seed	1946	624	550	220	–	1124	2518	447
"	1947	588	542	224	–	1497	2851	467
"	1948	580	544	195	–	1550	2869	609
"	1949	570	524	134	–	1622	2850	495
"	1950	562	496	160	–	1988	3206	505
Onions from sets	1946	462	32	26	–	–	520	110
"	1947	429	21	36	–	–	486	404
"	1948	448	25	31	–	–	504	400
"	1949	460	23	26	–	–	509	520
"	1950	478	10	15	–	–	503	480
Picklers	1946	–	88	6	–	–	94	–
"	1947	–	86	8	–	–	94	–
"	1948	–	79	8	–	–	87	–
"	1949	8	119	6	–	–	133	400
"	1950	10	67	2	–	–	79	474
Dry Sets	1946	–	–	–	123	–	123	–
"	1947	–	–	–	88	–	88	–
"	1948	–	–	–	–	–	–	–
"	1949	–	–	–	124	–	124	–
"	1950	–	–	–	–	–	–	–
Spanish type	1946	10	6	11	–	–	27	–
"	1947	9	16	13	–	–	38	–
"	1948	54	6	15	–	–	75	–
"	1949	99	5	20	–	–	124	–
"	1950	120	10	25	–	–	155	–

ORIGIN AND DEVELOPMENT

The onion was cultivated by man before history was first recorded. Cultivation probably started in Middle Asia and regions bordering on the Mediterranean Sea. Since then, types and varieties of onions have been developed that are suited for particular market preferences and for a large number of different growing conditions throughout the world.

White Portugal, a very old European variety, come to this continent with the first shipment of vegetable seeds. In 1834, Red Wethersfield, which was first listed as Large Red, was selected by growers at Wethersfield, Connecticut, from an unknown European variety. Yellow Globe Danvers, which was distributed before 1850 was developed near Danvers and Peabody towns, Essex County, Massachusetts, through selections of earlier ripening and deeper bulbs of a variety called Common Yellow.

Southport Yellow Globe, a name that is associated with the onion district of Southport, Connecticut, appeared in 1882; it was listed in 1865 as Large Yellow. White Globe was listed in 1868, and in 1875 became Southport White Globe. In 1873, Southport Red Globe was introduced; it is probably a selection from Red Wethersfield. Ohio Yellow Globe was listed in 1889 as Michigan Yellow Globe. Mountain Danvers, a selection from Yellow Globe Danvers was listed in 1914. Ebenezer was introduced after many years of selection in the Ebenezer section of New York, probably from a variety brought in by the German settlers. Early Yellow Globe, selected from Extra Early Yellow (selected from Yellow Globe Danvers in Orange County, N.Y.), was first listed in 1931. Brigham Yellow Globe was selected from Southport Yellow Globe for slightly deeper skin colour. Downing Yellow Globe was developed for a deeper skin colour and tighter fitting skins than Brigham Yellow Globe.

Sweet Spanish (Valencia) was introduced to America from Spain in 1916. Improved strains such as Riverside and Utah were developed in the United States.

Hybrid onions, as with a number of other vegetables, are coming into prominence. Hybrid onions were first sold in 1947. Three breeding lines are maintained, hence an onion hybrid is a three-way cross. A new supply of hybrid onion seed must be obtained each year; otherwise the advantages are lost and, in fact, the crop deteriorates in yield and quality.

PLANT CHARACTERISTICS

Germination and Seedling Development

Onion seed germinates at temperatures ranging from 46°F. to 86°F. But the optimum temperature for germination is about 64°F.

When germination begins, the embryo elongates in the lower and middle portion of the cotyledon (Fig. 5). The embryo root and the lower part of the cotyledon (seed-leaf) are thus pushed through the micropyle (a small opening in the seed coat). Shortly thereafter the seed-leaves start to bend downward in the regions of elongation above the stem-plate. The radicle (embryo root) then grows downward and the resulting bend forms a pointed knee. The regions of elongation are near the seed and just above the stem-plate.

Since the absorbing organ is embedded in the seed, and the root is anchored in the soil, and for a time both halves of the curve grow in length at the same rate, therefore the "loop" (see illustration) is forced to emerge from the soil. Then the growth on either side of the curve becomes unequal. The tension thus created draws the tip of the cotyledon out of the seed and above the soil surface. This stage of development is known as the "knee stage".

When the seed is not sown deeply enough, or is sown on loose, open soils such as sand, peat, or muck, the seed may be pulled from the growing medium.

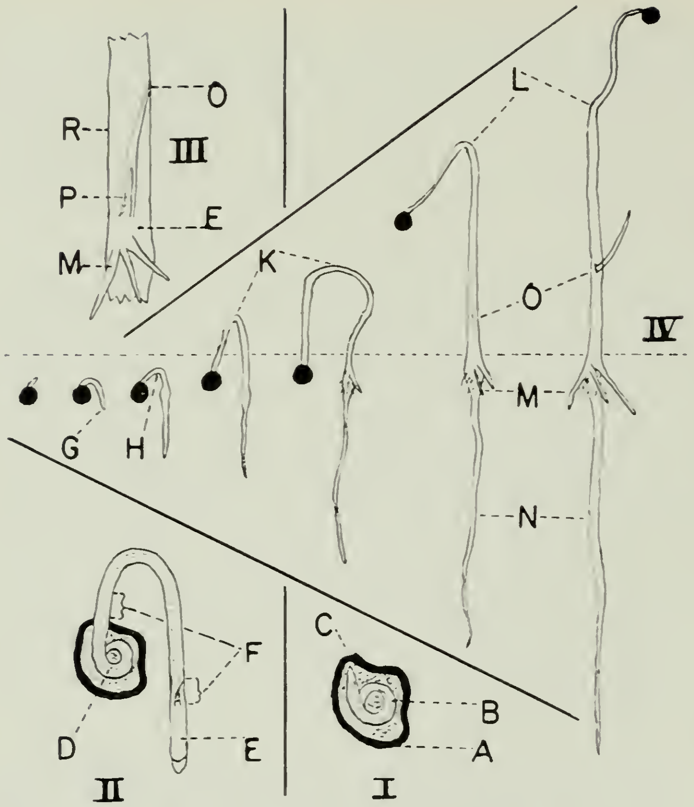


FIG. 5. I to IV. Germination and seedling development. (Redrawn from Anderson, P.J.: Massachusetts Agr. Exp. Sta. Tech. Bull., 4, 1921). A, seed coat; B, embryo; C, micropyle; D, absorbing organ; E, stem plate; F, regions of elongation; G, embryo root; H, pointed knee; K, loop; L, knee stage; M, secondary roots; N, primary root; O, longitudinal slit; P, first true leaf; R, cotyledon (seed leaf).

The seed then dries out and translocation of food material stops. On the heavier, more compact soils the seed may remain in the ground.

At the base of the seed-leaf, where it joins the exposed portion of the embryo root, a longitudinal slit is formed through which the first true leaf emerges. The cotyledon or seed-leaf later disappears.

Roots

The onion root-system is fibrous and shallow. The rather poorly branched fibrous roots arise from the stem-plate, and radiate in all directions. Those roots which arise from the centre of the stem-plate are the older roots. Usually they die and new roots form at the margin of the stem-plate. New roots are formed throughout the growing season.

Root development of the onion varies with different growing conditions, but the range of feeding is quite limited. Few onion roots penetrate into the soil deeper than 10 inches or extend horizontally farther than 6 to 12 inches. Most of the roots occur within a radius of 6 inches of the stem. On peat and muck soils a few roots may penetrate to a depth of 20 inches and a lateral spread of 21 inches. Scallions (thick-necked onions) develop a larger root system and the roots live longer than those of normal bulbs.

Leaves and Stem

The leaves, which arise from the very short, conical stem-plate at the base of the bulb, are cylindrical, hollow, and with parallel veins. A longitudinal slit is formed at the tip of the leaf-bases, and the inner leaves emerge through this slit. The outer leaves are the oldest and surround the younger leaves by their sheaths (swollen and expanded leaf-bases). After the leaf-bases have thickened, they become the "scales" of the onion bulb. If the bulb does not mature properly and the leaf-blades continue to develop, undesirable thick-necked onions are formed.

Bulb

Series of thickened leaves and leaf-bases arise from the short conical stem or stem-plate. The leaf arrangement is concentric, that is, the older leaves surround the younger leaves. The growing point is located at the centre of the bulb. Some of the inner leaves do not develop leaf-blades and become storage organs. Several of the outer leaves dry, break off, and their sheaths become the protective covering for the remaining storage leaf-bases.

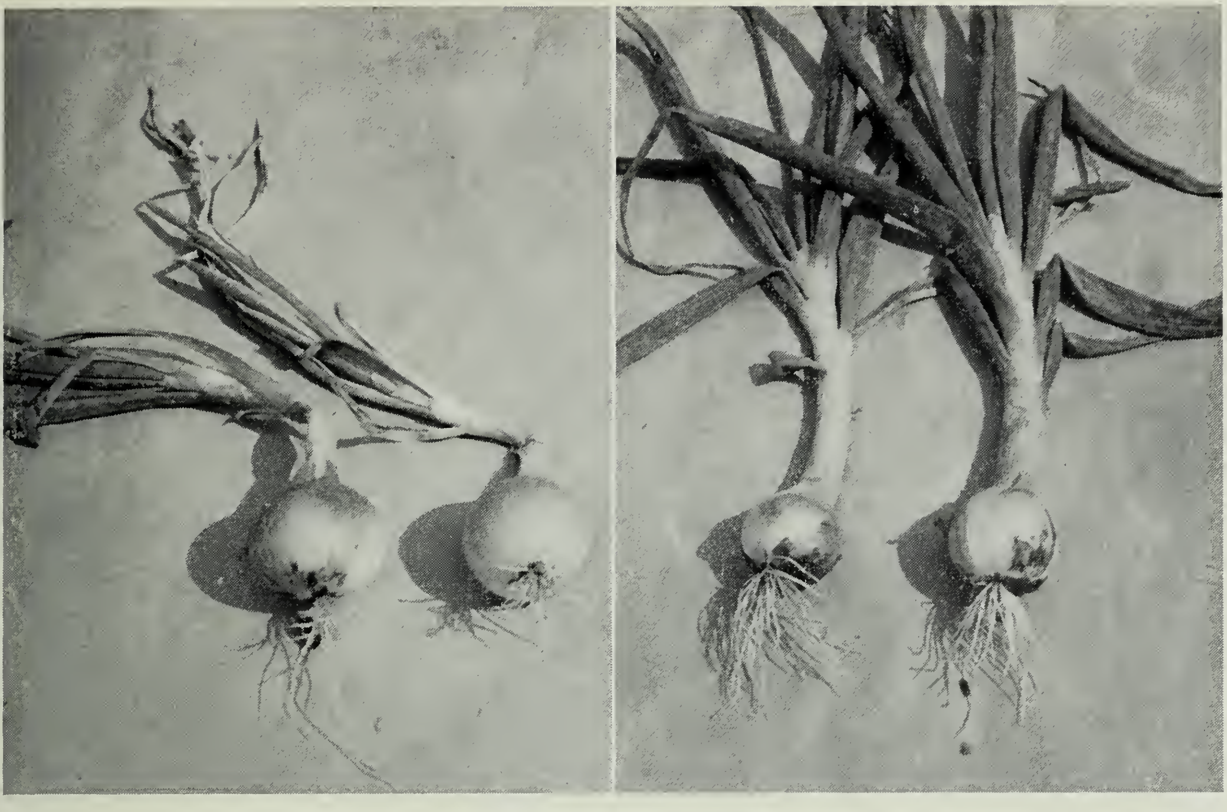


FIG. 6. Properly ripened tops (left); undesirable scallions or thick-necked onions (right).

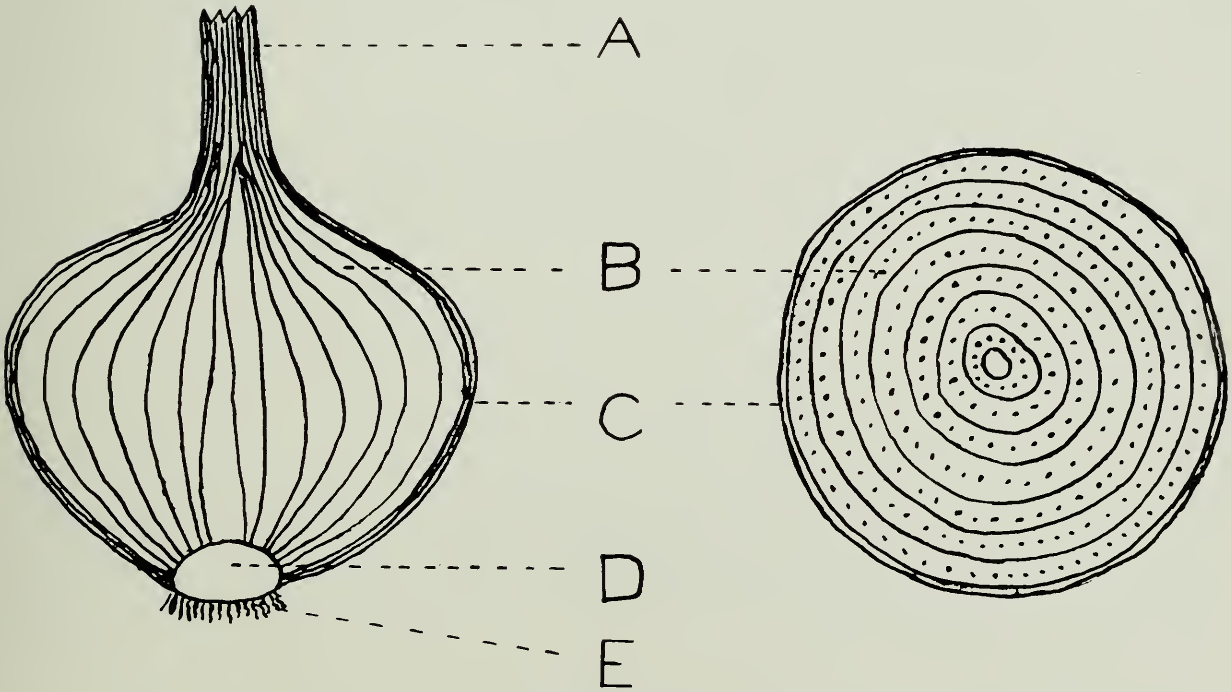


FIG. 7. A — Leaf-blades which are extensions of some of the enlarged storage leaf-bases. B — Fleshy storage leaf-bases. C — Protective dried sheaths of outer leaves. D — Compressed conical stem. E — Roots.

The size of the plant at the time bulb formation starts is closely related to the size of bulb at maturity. Any factor or factors which interfere with plant growth will result in smaller bulbs at maturity.

Larger bulbs may be produced through the use of transplants than from direct seeding. This is particularly true for the late-maturing, large bulb varieties.

CLIMATE

Temperature

The onion is adapted to a wide range of climatic conditions. It is highly frost-tolerant and usually withstands an air temperature of 28°F. without injury. However, varietal differences occur in resistance to freezing and with respect to the effects of high temperature. Cold, wet soil conditions during the early stages of growth will cause young plants to become stunted, with twisted and yellowish-green leaves. Nevertheless the largest yields are obtained when the temperature is comparatively cool before bulbing occurs. During bulb formation, lifting, and curing, high temperatures and low humidities are best.

Length of Day

Temperature alone, however, is not necessarily the critical factor in the success or failure of a variety in a particular locality. Length of day exerts a strong effect on the growth of the onion. The time when an onion plant will start to bulb is governed more by length of day than by age of plant.

The length of day necessary to initiate bulb formation differs among varieties. It ranges from 12 hours for the extra early varieties to about 14 hours for the late types such as Sweet Spanish. Early varieties can start bulb formation during short daylight periods and then develop rapidly. But, early varieties do not have time to develop large tops and roots during the comparatively cool, shorter days of spring and early summer that are necessary to support large bulb formation. Therefore, earlier sowing, within limits, results in larger yields because the plants will be larger at the time the length of day influences bulb formation. Late varieties develop more slowly than earlier varieties and are exposed to longer minimum daylight periods.

The productivity of an onion variety in a new locality can be fairly accurately foretold by comparing the length of the growing season and the daylight period of the new area with that of the region from which the variety is introduced.

Moisture

As with most vegetable crops, a steady, continuous growth of the plants is desirable. During the early period of growth, adequate soil moisture must be present near the surface as new roots cannot form unless the stem plate is in contact with available moisture. If a check in growth is caused by a shortage of water the outer scales tend to ripen prematurely. When normal growth is resumed, the inner scales enlarge and split the outer ones. This is one of the main causes of split, bald, and double onions; hence a uniform, adequate supply of moisture is desirable.

SOIL

Because the seedlings are delicate the soil should be friable, easy to work, not inclined to bake, and reasonably free of weeds, stones, and rubbish.

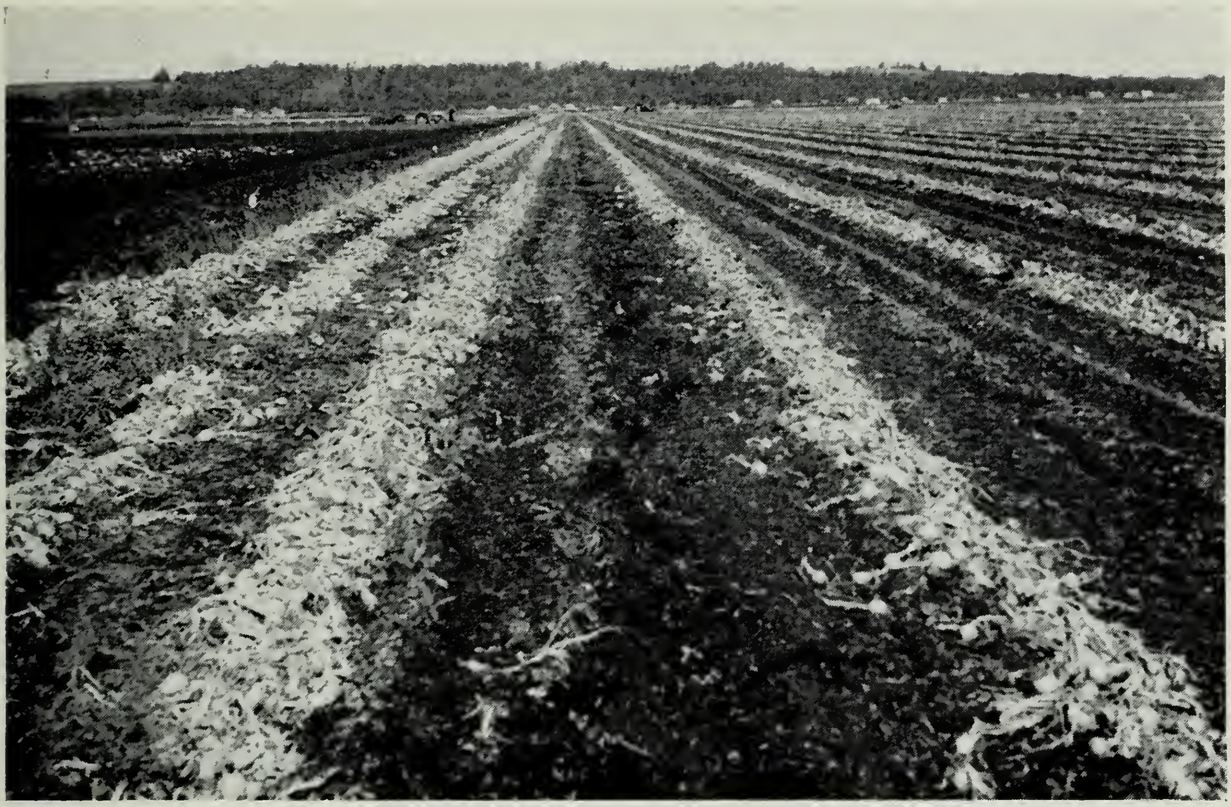


FIG. 8. Onion yields are greatly reduced when the drainage is not adequate. The rows close to the drainage ditch (left) produced double the yield of the same number of rows in the centre of the field (right) in a wet year.

The land should be level to avoid wind and water erosion, and it should be well drained.

Peat and muck soils provide nearly ideal conditions for the production of onions. Such soils, in Ontario, are loose, friable, retentive of moisture, and cool. The yield is higher and the cost of production is lower than on mineral soils. Therefore, the culture of onions for storage is practised chiefly on peat and muck areas.

Sandy-loam soils, if they are well supplied with organic matter, nutrients, and a uniform supply of moisture, also provide an excellent growing medium. Onions grown on light sandy-loam soil will generally mature earlier than on heavier soils.

The heavier soils such as clay should be avoided because they may become hard and compact, and so make the emergence of seedlings difficult. Heavy soils also cause misshappen bulbs.

Soil Reaction

Soil reaction is commonly measured in terms of pH (hydrogen ion concentration). A pH of 7.0 indicates a neutral soil; a pH above 7.0 indicates an alkaline soil; and a pH below 7.0 indicates an acid soil. Onions grow best on a soil which is normally slightly acid to neutral (pH 5.8 to 7).

Influence of Previous Crops

Producing onions in a rotation with other crops is desirable because rotation of crops aids in the control of diseases and insects. Also, a rotation, in which deep-rooted crops are alternated with shallow-rooted crops, makes better use of land resources.

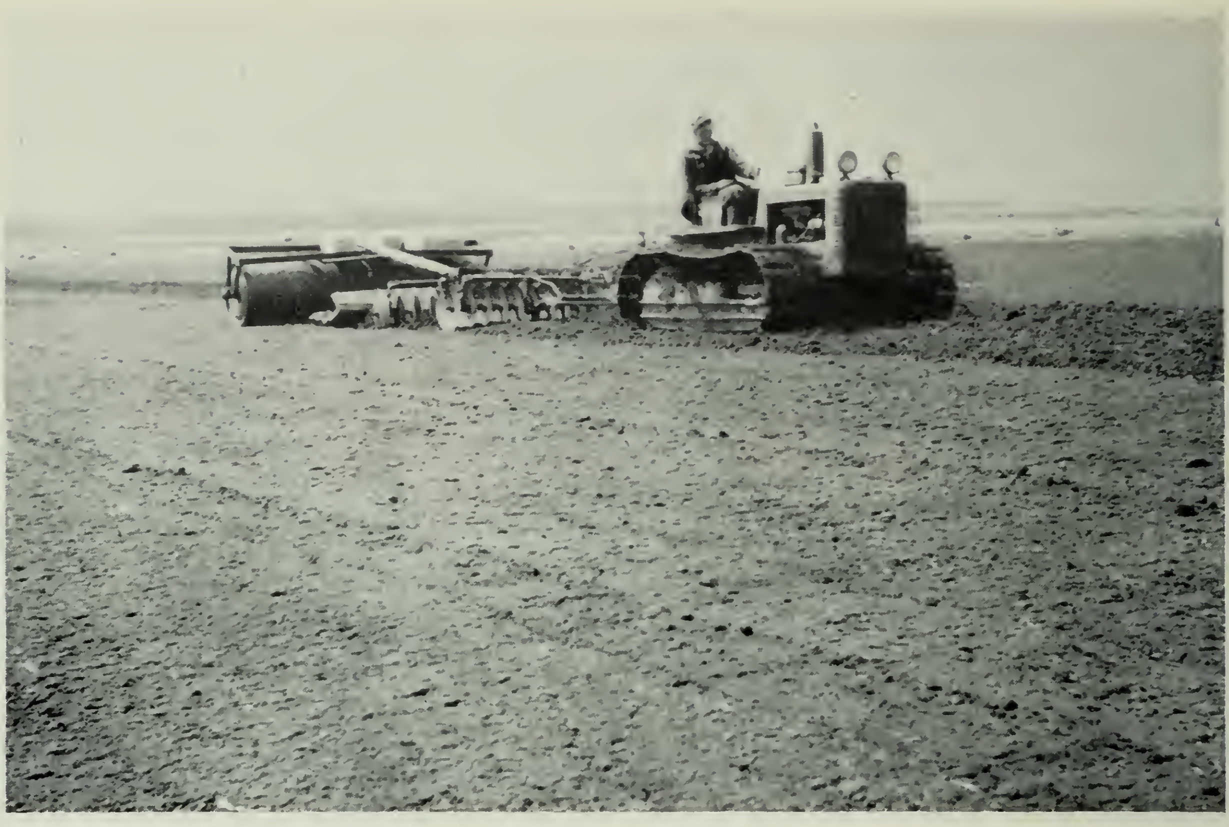


FIG. 9. Discing, floating, and rolling marsh land in one operation.

Even though optimum amounts of lime and fertilizer added to the soil tend partly to overcome the affects of one crop upon another, the onion still seems to be somewhat sensitive to certain conditions created by the previous crop. For example, growers on marsh land find that onions do not thrive well after potatoes. Also, where only a few different crops are grown, thereby making good crop rotation impractical, the practice of planting onions year after year will produce better yields than rotating with a crop or crops to which onions may be adversely sensitive.

In an experiment conducted in the State of Rhode Island, a number of different crops were grown in the same plots for two years and then were followed by onions in the third year. The average yields of onions for the three years, 1936, 1939, and 1942 were as follows: 604 bushels per acre of onions after rye, 494 after oats, 485 after buckwheat, 484 after corn, 474 after carrots, 420 after onions, 418 after millet, 354 after potatoes, 336 after mangels, 276 after cabbage, 116 after rutabagas. The difference necessary for significance was 142 bushels per acre. It would appear that the yield of onions is adversely affected when onions are preceded by crops of mangels, cabbage, and rutabagas. Rye is an outstanding crop to precede onions, whereas oats, buckwheat, and corn are favourable.

Soil Preparation

Onions in general, and particularly those grown from seed, need a well-prepared soil. In fact, the soil must be in a finer state of tilth and firmer than is required for most vegetables. The seedbed should be thoroughly pulverized; its surface should be level and smooth.

Fall plowing is preferred on mineral soils as a greater surface is exposed to the pulverizing action of frost; also, moisture is more readily retained during the fall, winter, and early spring. Loose and open muck-soil types need not be plowed as onions seem to thrive better when a hard bottom is left by discing. In the spring, muck soil is thoroughly disced, harrowed, and floated or rolled until it is free of clods, and is level and smooth.

It is generally wise not to plant onions until the third or fourth season after breaking marsh land. A large amount of nitrogen becomes available to plants on such land when the soil is warm, and this causes excessive top growth at the expense of bulb formation. Growing of other crops, such as lettuce and potatoes, on new marsh soils helps to break down the raw organic material.

MANURE AND FERTILIZER

The cost of production, harvesting, and preparation for market of the intensively cultivated onion crop is quite high. Therefore, it is important to prepare the soil in the best physical condition possible and to provide an optimum supply of plant food throughout the growing season.

Farmyard Manure

The application of farmyard manure aids in maintaining organic matter in the soil and supplies plant food. Farmyard manure is low in phosphorus however, and so superphosphate should be added to create a proper balance of the three major plant-food elements, nitrogen, phosphorus, and potassium. Well-decomposed farmyard manure should preferably be used and it should be incorporated into the soil before the seed is sown. When the farmyard manure is not well-decomposed it may be applied in the fall to permit decomposition before spring. Fresh farmyard manure tends to cause excessive top growth at the expense of bulb size.

Applications of 15 to 20 tons per acre of well-rotted manure may be given. However, lighter applications of 5 to 10 tons are usually made, and are supplemented with green manures and commerical fertilizers.

Green Manure

Farmyard manure has become increasingly difficult to obtain, and so growers on mineral soils often plow down green-manure crops to obtain some of the needed organic material. Soy beans and buckwheat are excellent crops for plowing down in the fall. An over-wintering crop of rye is often sown to aid in the prevention of wind and water erosion, and to supply some organic material.

The cover crop should be plowed down well in advance of seeding to allow the material to become adequately decomposed. The addition of a nitrogen fertilizer, such as calcium cyanamide, at plowing time increases the rate of decomposition. On muck soils, green manures are preferred to farmyard manures because the latter usually contains weed seeds. Despite high crop and land values, growers are well advised to include in their crop rotations a portion of their land for the production of green manure crops.

Nitrogen

A deficiency of available nitrogen in the soil causes the foliage to become yellowish green, dwarfed, and somewhat twisted or curled. Cold, wet soil may make nitrogen temporarily unavailable even though a sufficient quantity of the element was added in the commercial fertilizer. A side-dressing of a quickly available nitrogen fertilizer may give beneficial results if the cold spell is prolonged.

FIG. 10. Broadcasting commercial fertilizer for the onion crop.

At the beginning of the ripening period the tissues above the bulb become soft, the tops fall over, the leaf growth ceases. This normal softening of the tissues above the bulb does not seem to take place when nitrogen is deficient. On the other hand, an over-supply of nitrogen during the growth period tends to produce excessive top growth.

Phosphorus

The characteristic deficiency symptoms of phosphorus, as exhibited on the foliage, are generally less pronounced than those of some of the other plant-food nutrients. A deficiency of phosphorus causes slow growth, delayed maturity, light green foliage, and few dried outer scales.

Potassium

Shortage of potassium causes dark green, erect leaves to develop. Subsequently the leaf-tips turn brown and wither. The plants show reduced vigour, greater susceptibility to disease, and retardation of growth.

Optimum levels of potassium improve the quality, increase the resistance to certain diseases, and offset an over supply of nitrogen. When the proportion of phosphorus to potassium is increased the maturity date is hastened and therefore is beneficial for late plantings, late-maturing varieties, and for planting on soils that are somewhat too acid, alkaline, or poorly drained.

Copper

A deficiency of copper in the soil is indicated by light bronze-coloured bulbs, thin scales, and soft bulbs with poor keeping quality. The outer scales break off easily in handling, thus giving the bulbs a bald appearance and making

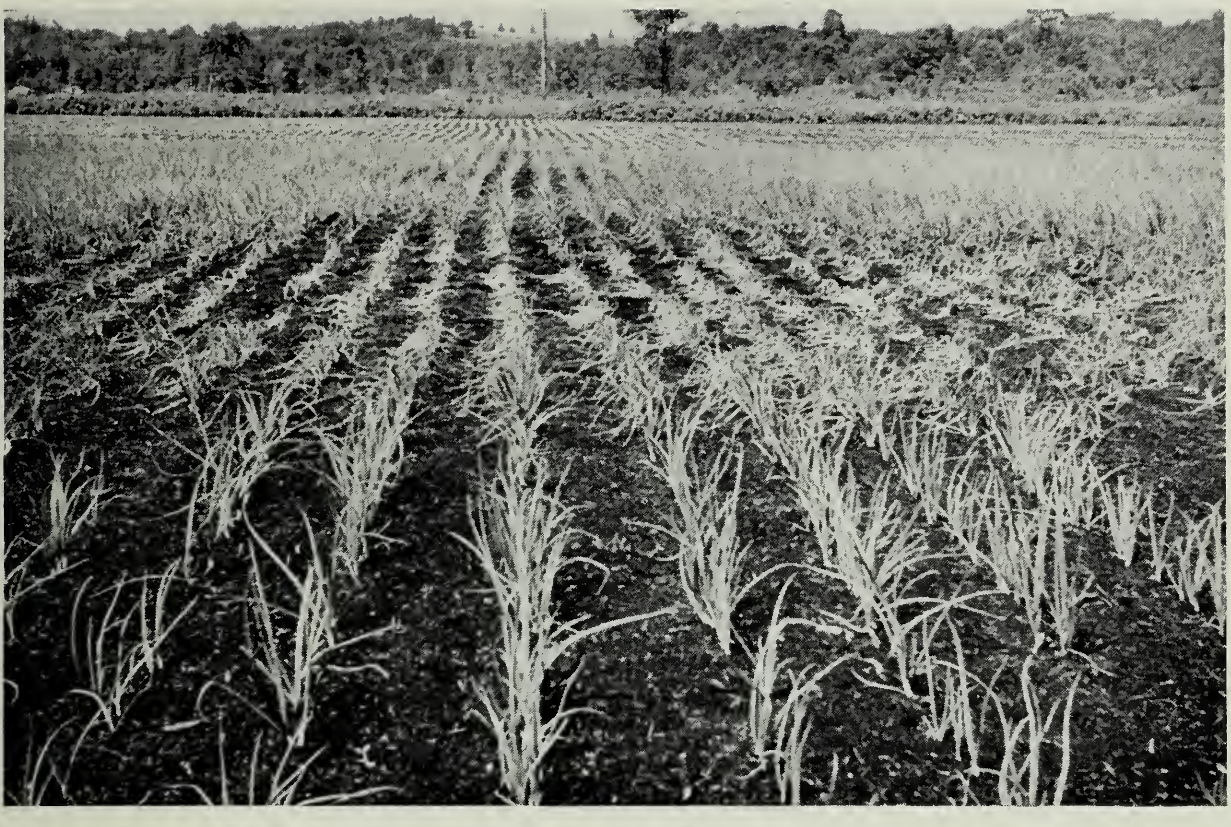


FIG. 11. Lightning damage in an onion field.

them more susceptible to bruising. Most mineral soils contain sufficient quantities of copper for normal growth, with the exception possibly of very sandy soils that leach easily.

Copper deficiency is of economic importance in commercial onion production on most of the peat and muck areas. When 300 pounds per acre of powdered copper sulphate have been built up in the soil, no further applications need be made unless the skin of the bulbs become light bronze in colour. Onions growing on muck soils usually are supplied with copper in the form of finely ground copper sulphate mixed with the commercial fertilizer in the proportion of 100 pounds to the ton.

Manganese

Symptoms of manganese deficiency in onions are characterized by a gradual yellowing of the leaves, with the main veins remaining green. The leaves become curled or twisted and the plant becomes stunted in growth.

The condition may be corrected by adding 100 pounds of commercial grade manganese sulphate per acre. Soils that are highly calcareous, that have been over-limed, that are very acid, or sandy types that leach easily, will probably require more frequent and heavier application. In order to obtain quick results in the current crop, it is wise to apply manganese sulphate in the form of a spray. Two applications of 4 pounds of commercial grade manganese sulphate dissolved in 50 gallons of water may be necessary. Sufficient of the solution is applied to thoroughly wet the leaves.

Magnesium

Onion plants develop a chlorosis or lack of normal green colour of the older or outer leaves when the magnesium supply is inadequate. The leaf tips become prematurely brown.

A deficiency of magnesium in the soil may be corrected by applying dolomitic limestone. To obtain quicker results, magnesium may be applied as a spray at the rate of 2 pounds of commercial grade magnesium sulphate dissolved in 10 gallons of water. Sufficient of the solution is applied to thoroughly wet the leaves. Four applications throughout the growing season may be necessary.

Fertilizer Recommendations

Fertilizer recommendations can only be made here in a general way as the fertility level in a soil may vary considerably from field to field and parts of a field, from farm to farm, and from one locality to another. It is wise to use soil tests as a guide to intelligent fertilizer application. For information on soil sampling and soil testing services, consult The Ontario Department of Agriculture bulletin on "Soil Management and Fertilizer Use".

A general recommendation for muck soil is 1200 pounds per acre of a 3-12-16 commercial fertilizer. For mineral soils, either light or heavy, 800 pounds per acre of 5-10-13, or 1000 pounds per acre of 4-8-10, commercial fertilizer may be used. Side dressings of nitrogen and potassium fertilizers may be given as required.

Where minor-element applications are indicated, the methods and rates of applications are as previously described. Should there be any other suspected minor-element deficiency, diagnosis and recommendation should be made by a qualified person.

SEED

Growers should secure seed from a reliable seedsman. The price of seed is such a small part of the total cost of production that it is poor economy to use anything but the best.

Onion seed should be fresh. Although the average life or viability is two years, the percentage germination may drop very quickly after the first year. The average percent strong germination of 1-year-old seed is 75 aud it is not unusual to obtain a percentage germination of 95.

Onion seed should produce true to type. The resulting bulbs should be fairly uniform as to size, shape, and intensity of colour. There should not be any off-types such as reds or whites mixed with a yellow variety in the crop. The tops should ripen down uniformly.

Proper storage conditions are important in relation to viability or length of life of the seed. A storage temperature of 34° to 36°F. and low relative humidity seem to be the most suitable. Seed stored under warm, humid conditions or at room temperature may deteriorate rapidly in ability to germinate well. Growers who have obtained an over supply of seed for the current season may, through proper storage, profitably save the seed for next season's crop.

MATURE ONIONS GROWN FROM SEED

Cost of Production

Most of the onions grown in Ontario are produced from seed sown in the field where the crop is to mature. This method of growing onions provides the lowest cost of production in areas where conditions are favourable for its adoption. Cultivation, weeding, and thinning comprise the greater part of the cost of

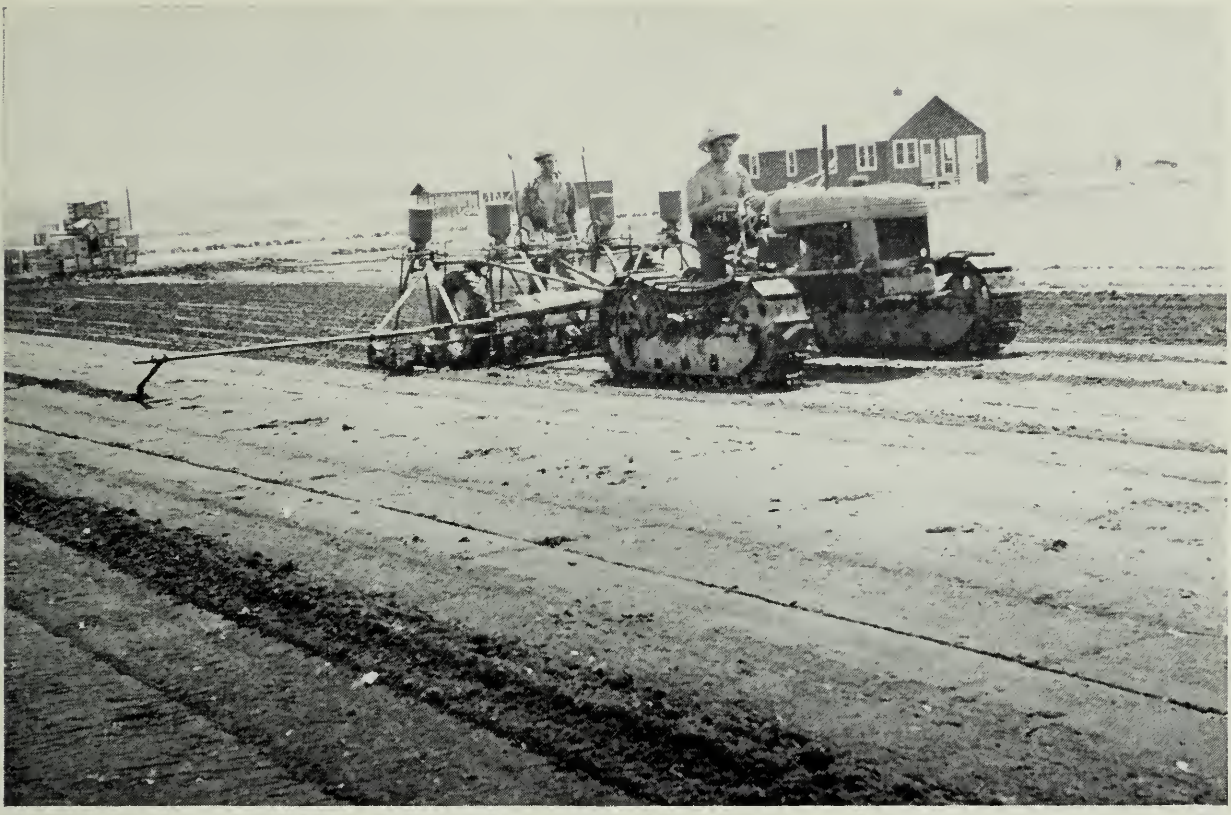


FIG. 12. Eight-row seeder on marsh land.

production. Direct seeding is used almost entirely for the production of the American-type varieties such as Early Yellow Globe, Brigham Yellow Globe, and Southport Red Globe.

Sowing Time

Onions grown from seed require a relatively long growing period. They must attain ample growth by the time favourable weather and suitable length of day for bulb formation arrive. Therefore the seed should be sown as soon as the hard freezes are over in the spring and the soil can be worked properly. On muck soils, the seed may be sown when the frost is out of the soil to disc depth. A good time to sow onions is within a 2-week period after the soil is in workable condition. However, usually the earlier the seed is sown in this period the larger will be the yield. Later seeding, or late spring seeding, may result in poor maturity, poor keeping quality, small-sized bulbs, and many scallions (thicknecks).

Sowing Rates

A number of factors govern the rate of seeding. In order to obtain the desired stand it is important to know (1) the percentage germination when adjusting the seeder, (2) the size of seed as it varies from year to year and so will alter the drill setting accordingly, (3) the soil moisture supply, and (4) the possible injury from damping-off, smut, wireworms, and onion maggot.

Six to 12 plants per foot of row are generally optimum on mineral soils and 12 to 15 on muck soils. To secure these stands, sowing 15 to 20 seeds per foot of row may be necessary. To insure a good stand of Early Yellow Globe and similar-type varieties, 2½ to 3 pounds of seed per acre are sufficient if the row

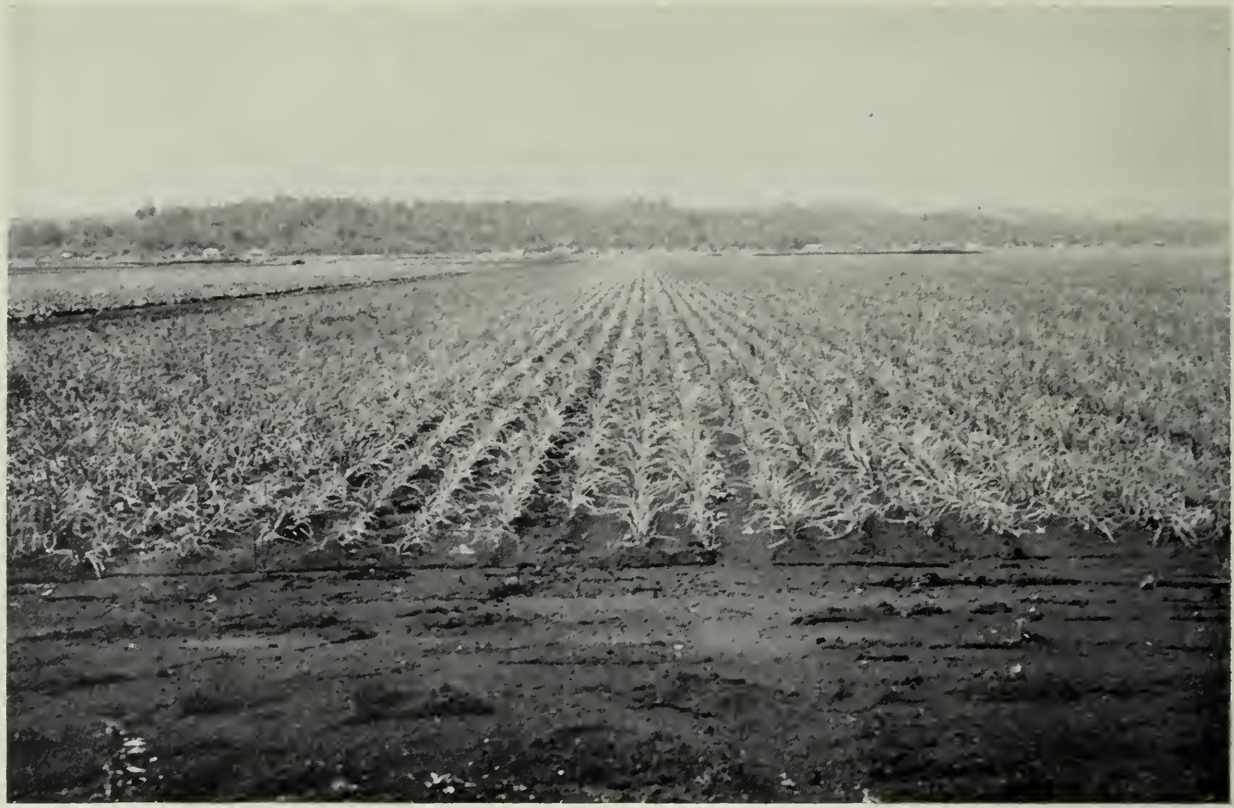


FIG. 13. A field of onions grown from seed for storage purposes.

spacing is 16 inches, the soil is loose and open, and other growing conditions are adequate. The seedlings may need to be thinned if the stand is too thick.

Spacing

The kind and type of equipment which will be used is a factor determining the spacing between rows, as the rows must be far enough apart to accommodate machine widths. The spacing may also depend upon the amount of land available and the variety to be grown. Wide-spaced rows allow freer movement of air and thus help to prevent the spread of onion blight. Since the moisture content must be ample during the vegetative growth period, the spacing between rows must be based to some extent on the moisture-holding capacity of the soil and whether irrigation will be practised.

The distance between rows varies from 12 to 18 inches in different plantings. Most commercial growers prefer 16-inch spacing.

Depth of Sowing

Although the depth of sowing must be varied with the type of soil, the most important point is to see that the seed is placed in moist soil. In mineral and muck soils, where there is high water-holding capacity and an ample moisture supply, the seed may be sown at a depth of ¾ to 1 inch. On heavier mineral soils and on muck soils that are inclined to form a hard crust at the surface, the seed should not be sown deeper than ½ inch. In excessively drained mucks and in areas where wind and water erosion are factors, the seed should be sown at a depth of 1¼ to 1½ inches.

Seeding Equipment

The seed is sown be means of various types of seed drills that range from a single hand drill to gang-drill equipment. With a single hand drill one man can easily sow one acre in a day. Gang drills, which contain two or more seed drills that are drawn by tractors, are used on large acreages. Gang-drill equipment is useful in saving time on large acreages. Also, it spaces the rows accurately across the field, so that cultivation equipment, which covers the same number of rows seeded, can follow in perfect alignment with the rows of onions.

Varieties

The leading yellow-onion varieties in the mature-bulb class are Early Yellow Globe, Brigham Yellow Globe, Yellow Globe Danvers, and Downing's Yellow Globe. These are hard, late-maturing, storage varieties. The bulbs are dense-textured, firm, and strongly flavoured.

The yellow-scaled varieties predominate on the markets. The white-scaled and red-scaled varieties are in limited demand. Only a few markets show preference for bulbs of these colours.

Early Yellow Globe is still the most popular variety for earliness and short-term storage. The average bulb size is larger and the yield is higher than for the following later-maturing, longer-storage varieties. *Brigham Yellow Globe* is now the standard storage variety for the larger onion-producing areas. Some of its merits are: uniformity in shape and size; thick, deep-bronze-coloured scales; superior keeping qualities. *Downing's Yellow Globe* is featured by deeper coloured and tighter fitting scales than Brigham Yellow Globe but averages somewhat smaller in size in some producing areas. *Yellow Globe Danvers* produces a good yield of medium-sized, globe-shaped bulbs. It possesses good storage qualities but lacks the attractive scale colour of Brigham Yellow Globe and Downing's Yellow Globe.

PRODUCTION OF DRY-ONION SETS

Dry-onion sets are very small, mature bulbs of varieties that normally produce large-sized bulbs. The sets are obtained by sowing seed very thickly. The plants thus compete with one another for space in which to grow, for moisture, and for nutrients. This competition results in small and earlier maturing bulbs. Correctly graded and sized bulbs are used by growers the following year to produce an early large-bulb crop or early green-bunch onions.

Culture

The seed for the production of sets is sown as soon as the soil can be properly worked in the spring and when the danger of hard freezes is over. The distance between rows varies slightly under different conditions but commonly is 12 to 14 inches. Seeding is done at the rate of 50 to 90 pounds per acre, depending upon the row spacing, percentage germination, fertility, and moisture. Since the ordinary shoe on a seeder would concentrate the seed in a narrow band, specially constructed wide shoes with a seed-spreader attachment are used to plant the seed in bands 3 to 4 inches wide.

Harvesting

The storage period for sets is much longer than for the large-bulb crop; therefore proper maturity is essential. Harvesting generally begins when the tops weaken and fall over in the region just above the small bulb.

In one method of harvesting and curing, the onions may be pulled by hand and the tops twisted off as the bulbs are placed in the picking containers.

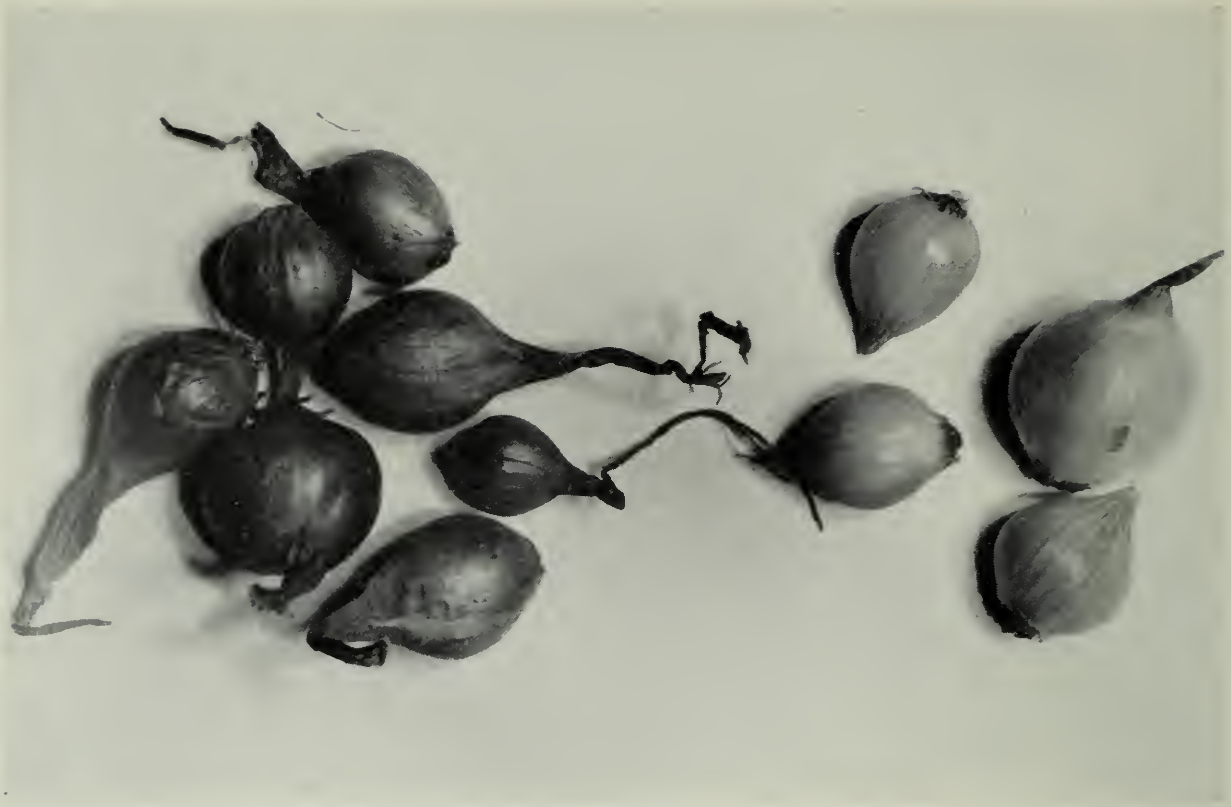


FIG. 14. Onion sets.

The sets are then placed to a depth of approximately 4 inches in shallow trays. The trays are piled in the field in tiers, perhaps 8 high, to begin the curing process. There should be at least a 1-inch air space between trays. Covering the top trays with roofing paper protects the bulbs from inclement weather. The sets are left in the field as long as favourable drying weather lasts and are then removed to well-ventilated sheds to complete the curing process. When the bulbs have become dry the remaining parts of the tops may be rubbed off.

In some districts the sets are harvested by drawing a blade slightly below the bulbs just before the tops start to break down. The bulbs with tops intact are then placed in shallow trays, which are piled 7 to 8 high, and left in the field to continue the curing process. When dry and well cured the tops are rubbed off and then the sets are placed in storage.

In still another method of harvesting and curing sets, the plants are removed from the soil when the bulbs have reached the proper size. Two or more rows are pulled at a time and left in windrows so that the tops protect the bulbs from the sun. When the curing process is completed and the plants are dry, the tops are rubbed off. The sets are then placed in storage in shallow trays.

Considerable shrinkage occurs in storage. Therefore, growers sometimes prefer to sell in the fall when prices may be nearly as favourable as in late winter or spring.

Grading

The ideal size of set is ½ to ¾ inch in diameter. Those over ¾ inch tend to produce seedstalks. Sets under ½ inch produce weak plants or are lost by drying out in storage.

Varieties

Ebenezer is an excellent variety for the production of yellow sets. The sets and resultant mature bulbs possess very good keeping qualities. *White Ebenezer* is popular for the production of white onion sets and it too is a good keeper. *White Portugal* is also used for the production of white sets, but it does not keep as well as *White Ebenezer.*

ONIONS GROWN FROM SETS

Dry sets are planted by many home gardeners to produce green-bunch onions and for the mature-bulb crop. In home gardens, more satisfactory results may be obtained from sets than by direct seeding where the crop is to mature. Two important advantages of sets are: (1) growth is made early, thus allowing the plants to miss most of the damage caused by onion thrips; (2) if optimum growing conditions do not prevail during the early part of the growing season, the stored reserve food in the sets enables the plants to carry on through this period. The commercial vegetable grower finds, in addition to the foregoing merits, that the early maturity of the crop tends to spread the harvesting operations and marketing season for onions over a longer period of time.

There are some disadvantages to the set method of production. The insect problem in a particular locality is aggravated when sets, seedlings and seed onions are grown in close proximity. The thrip population builds up and spreads to later onions, thereby reducing their yield. Also, sets raised in a smut-infested area carry the spores on the scales and introduce the disease into new areas.

Cost of Production

Compared with direct seeding in the field, the set method of production is more expensive because of the cost of the sets and the labour involved in planting. This is especially true if the sets are planted by hand.

Planting Time

Multiplier sets and Egyptian sets can be planted in either fall or spring. Common onion sets should be planted as soon as the soil can be properly prepared in the spring. A few degrees of frost does not injure the young stems. Early spring planting is very important as a maximum amount of growth should take place before the long hot days that initiate bulb formation arrive. The planting date affects the yield more than it does the maturity date.

Planting Methods

Dry sets may be planted in the field by hand. But this is a rather expensive method as it involves considerable time and labour. Therefore, commercial growers who produce onions from sets, are using 1- or 2-row planters. These planters open up a shallow furrow, drop the sets, and cover them with soil.

To produce a green-onion crop the sets must be placed upright in the furrow. If this practice is not followed, crooked or malformed green onions will result. If the sets have been graded to a uniform size, planting machines will place them fairly accurately.

Depth of Planting

The depth of planting will vary with the soil type and according to whether a green-bunch or a mature-bulb crop is to be harvested. For long, well branched, edible portion in green bunch onions, the sets should be planted slightly deeper than is necessary for a mature-bulb crop. The bulbs should be barely covered in heavy soils, and should be set deeper in sandy soils.

Spacing Sets

The distance between rows ranges from 12 to 18 inches; 14 inches is the most popular spacing. To produce large, mature bulbs, the sets are planted 2 to 4 inches apart in the rows. For green-bunch onions, sets are placed 1 to 2 inches apart.

Planting Rate

From 15 to 30 bushels of sets may be required per acre depending on the size of sets, spacing, and purpose for which the crop is grown.

ONIONS GROWN FOR PICKLERS

Pickling onions are grown by the same method that is used for dry-set production, but a smaller amount of seed is sown per acre; 15 to 30 pounds of seed are usually sufficient. Harvesting is done when the bulbs have reached the desirable pickling size of ¾ to 1½ inches in diameter.

White Portugal (Silverskin) is the chief pickling variety.

ONIONS GROWN FROM TRANSPLANTS

The practice of starting onions indoors and transplanting them later in the field has several advantages. The necessary growing period for the Spanish type of onion is normally too long for direct seeding, for most production areas in Ontario. The transplanting method promotes earlier maturity. By starting the seed under glass the growing season is lengthened sufficiently to mature the crop, and to obtain large bulbs and high yields. By transplanting, the stand is usually more uniform and weeds are more easily kept under control.

The chief disadvantages of this method are as follows: considerable time and labour are necessary to raise the plants and to transplant them into the field; special equipment such as hotbeds or greenhouses is needed, as well as transplanting machines to eliminate laborious and tedious hand planting.

Seed Sowing

Approximately 10 weeks are required for growth from the time of seed sowing to the time of transplanting in the field. The seed is sown rather thinly under glass, either broadcast, or in rows at the rate of 10 or 12 seeds to the inch. The rows are 3 to 4 inches apart and the depth of sowing ranges from ⅛ to ½ inch.

Seed treatment with an organic mercury compound aids in the prevention of pre-emergence damping-off. Watering should be done very carefully, particularly on dark days. On clear days, watering should be done in the morning so that the soil surface and seedlings are dry before nightfall. Cool temperatures are needed for best seedling development. A night temperature of 50°F. and a day temperature of 60-65°F. are good. Slightly higher temperatures on clear days are not usually harmful.

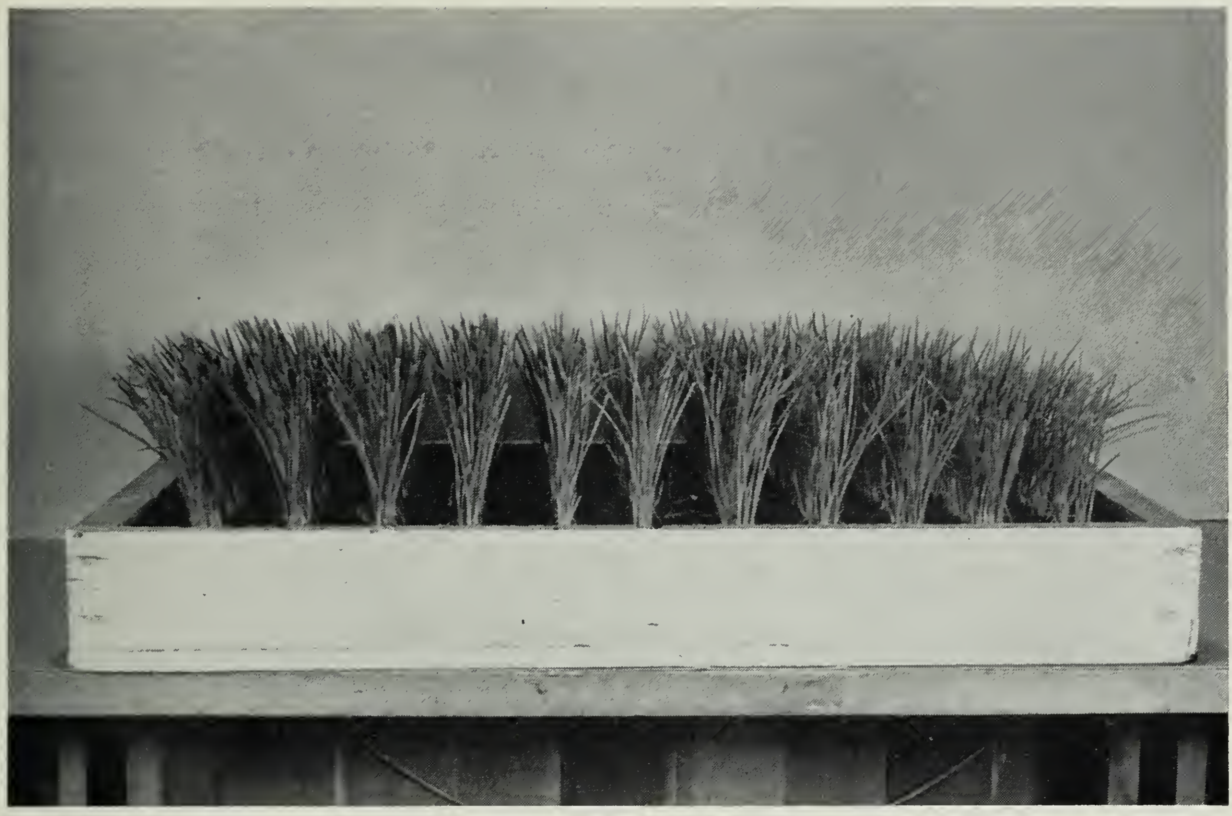


FIG. 15. Sweet Spanish type of onion in a flat ready for transplanting to the field.

Trimming

Cutting back the tops of seedling onions may be necessary to promote sturdiness and to facilitate handling at transplanting time. The trimming is usually done a few days before transplanting so as to give the cut surfaces time to heal. Also, root trimming done at this time stimulates the young plants to produce fibrous roots and it facilitates handling in transplanting.

Onion growers often find that trimming the tops once is not sufficient. Two or more trimmings may be necessary if growth is too rapid, or if some factor, such as insufficient light, is causing the seedlings to become tall and slender. Shears or a knife may be used. At no time should the seedlings be trimmed back to less than 4 to 6 inches.

Hardening

It is usually wise to harden the seedlings before transplanting. The hardening may be done by withholding water, by exposing the seedlings to cooler temperature for about one week, or by both methods. A good plan is to water the seedlings less frequently and to expose them to night temperatures of 40° to 45°F. for a week or 10 days before transplanting.

Transplanting

The best time to transplant to the field is as early in the spring as weather and soil conditions permit. Strong root development and strong tops should be attained before the long, warm days of summer. The plants should be about half the thickness of a lead pencil when transplanted.

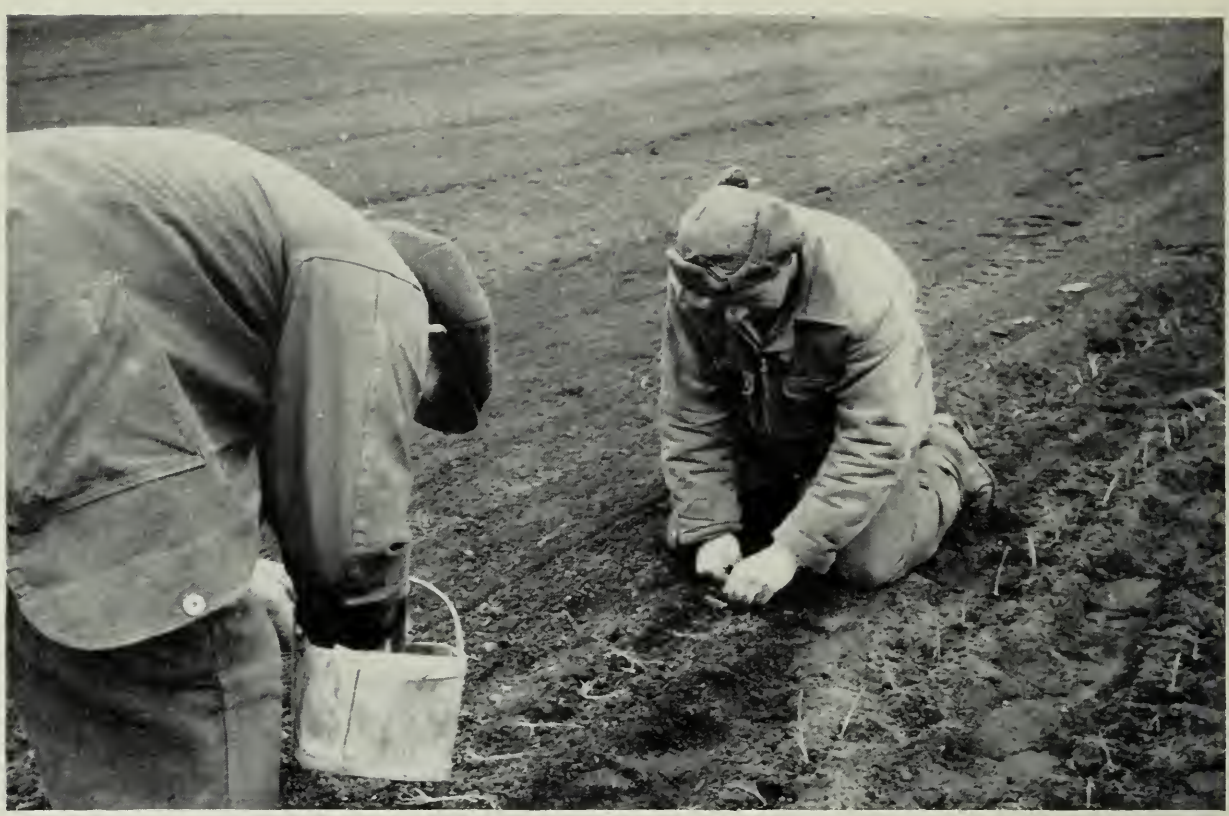


FIG. 16. A hand method of transplanting the Sweet Spanish type of onion.

A good depth of transplanting is such that the point of attachment between the root and the tops is ¾ to 1 inch below the soil surface. The soil should be well firmed about the roots.

The spacing of onion transplants is usually 4 to 6 inches apart in rows 1 to 2 feet apart, depending upon the soil type, fertility, moisture supply, variety, and equipment used. Generally, however, the closer the spacing, the larger will be the yield, but the bulbs will be smaller.

Transplanting may be done either by hand or by machine. When done by hand, a short stick or dibble is used to make a hole and to press the soil about the roots. An alternative hand method is to place the seedlings along the side of a shallow furrow and press the soil firmly against them. The self-steering and self-propelled celery transplanter may be used to set the transplants in the field.

Varieties

The Sweet Spanish type of onion is large in size, late in maturity and is generally considered to have a short-term storage period. The texture is medium grained and the flavour is mild.

Hybrid Sweet Spanish is outstanding for the production of the transplanted Sweet Spanish crop. It is uniform in shape and size, is earlier, and develops fewer thicknecks than do standard varieties. *Riverside Sweet Spanish* is a standard variety in the open-pollinated class. *Early Grano* (Babosa) is very early, medium sized, and small-necked.

ONIONS GROWN FOR GREEN BUNCHING

Onions which are pulled in the green or immature stage and sold in bunches are called green-bunch onions. They are appetizing throughout the year and particularly so during the spring months. Most home gardeners grow some onions of this type. Market gardeners raise green-bunch onions extensively for the local market.

When marketing green-bunch onions, the young, or immature, plants are pulled and washed. The roots are then trimmed off close to the base of the onions by hand or knife. The older outside scales are removed, leaving the somewhat swollen and compact leaf bases white and clean. The green onions are tied in bunches of 3 or up to 12 depending upon their size. The tops are then trimmed uniformly.

Bunch Onions from Sets

The simplest method, and also the earliest method, of producing green-bunch onions outdoors is from dry-onion sets. The sets are planted very early in the spring; the growth from them is ready to eat in 5 to 7 weeks. The larger the sets the sooner they will produce green onions of edible size. But large sets tend to produce seedstalks quickly, become coarse in texture and strong in flavour, and therefore should be harvested as early as possible. *White Portugal* and *White Ebenezer* are the leading varieties for the production of bunch onions from sets.

Bunch Onions from Seed

Growing bunch onions from seed is practised to a considerable extent by home and market gardeners. As the growing period from seed is longer the bunch-crop season is prolonged beyond that of bunch onions from sets. Seed is sown somewhat thicker than is normal for the mature-bulb crop and the seedlings are thinned later than usual. The thinning procedure, however, should not be delayed so long that the development of the bulb crop is adversely affected. The thinned-out plants are then used as green onions. *Southport White Globe* is used extensively for the production of bunch onions from seed.

Egyptian or Perennial Tree Onion

The Egyptian onion differs from other types of onions in its method of reproduction. Bulblets are produced at the tips of the seedstalks where seed-pods are formed in other onions. The bulblets or sets are usually red in colour and when planted will produce green onions; or if left until fall will produce mature, small, red-coloured bulbs. The bulb at the base divides, as in multiplier onions, into smaller bulbs and these small bulbs are transplanted for multiplication. This onion is winter hardy.

Propagation is usually by vegetative means, using either top sets or bulb divisions or both. Planting may be done in either spring or early fall, but fall planting will result in an earlier crop. Top-sets or bottom-divisions are planted about 1 inch apart in furrows about 4 inches deep. For a mature-bulb crop, the spacing should be about 6 inches in the row. Green onions produced from divided bottoms are ready for use somewhat earlier than those raised from top-sets. Mature bulbs are usually ready in late summer. As the season progresses the Egyptian onion becomes coarse in texture and strong in flavour.

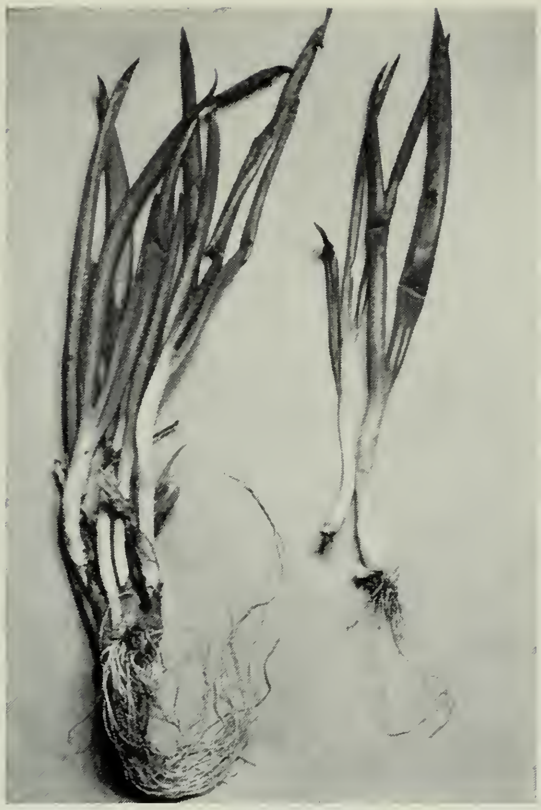


FIG. 17. Cibol or White Welsh onion, a non-bulb-forming type.

Non-Bulb-Forming Type

The non-bulb-forming type of onion, or cibol, includes the White Welsh, Japanese Bunching, and Nebuka strains. It is a perennial but is normally grown as an annual or biennial to produce long, green, bulbless shoots from the roots. This type of onion is extremely hardy, will over-winter successfully in the ground, and is highly resistant to diseases and insects. Propagation is usually done in the fall by means of clump division or from seed.

This type of onion is useful for greenhouse forcing. The seedlings, which tolerate freezing, are transplanted into flats in the late fall. They are brought inside at intervals to grow. Young green onions are preferred, as the older the plants become the stronger is the flavour.

Multiplier or Potato Onion

The multiplier or potato onion is not quite as hardy as the non-bulb-forming type but it may over-winter successfully when planted in the fall and mulched after the ground is frozen. The bulblets are planted 3 to 4 inches deep and are set 3 to 6 inches apart in the row for the production of green-bunch onions.

Shallot

The shallot is a distinct type, but the name is often loosely applied to any green-bunch onion, and particularly the multiplier type. The true shallot is a perennial and seldom produces seed. It forms a compound bulb with 2 to 20 cloves at the base. The cloves are not enclosed in a membrane as in garlic. The flavour is milder than that of the onion. The culture is similar to that for onions grown from sets, but the spacing may be somewhat greater.

Greenhouse Forcing of Storage Bulbs

The forcing of storage bulbs is a quick and relatively easy method of obtaining green onions for home consumption or for sale on the local market during winter and early spring. Mature, storage bulbs are planted shallowly, side by side, in soil in a greenhouse, hotbed, or coldframe. The soil in raised benches in greenhouses should be about 2 inches deep. Bulbs which are graded No. 1 small are the most economical to use as they are cheaper than No. 1 Large and more green onions can be obtained per square foot of greenhouse space.

After planting, a temperature of 60° to 65°F. is maintained and water is supplied as needed. When the green shoots are of acceptable market size, the bulbs are cross-sectioned with a large knife slightly below the centre. The lower half of the bulb is left rooted in the soil; the upper half is removed from the shoots and discarded. The shoots are then cleaned and marketed like other green-onion types. (See Figs. 19, 20, 21, and 22.)

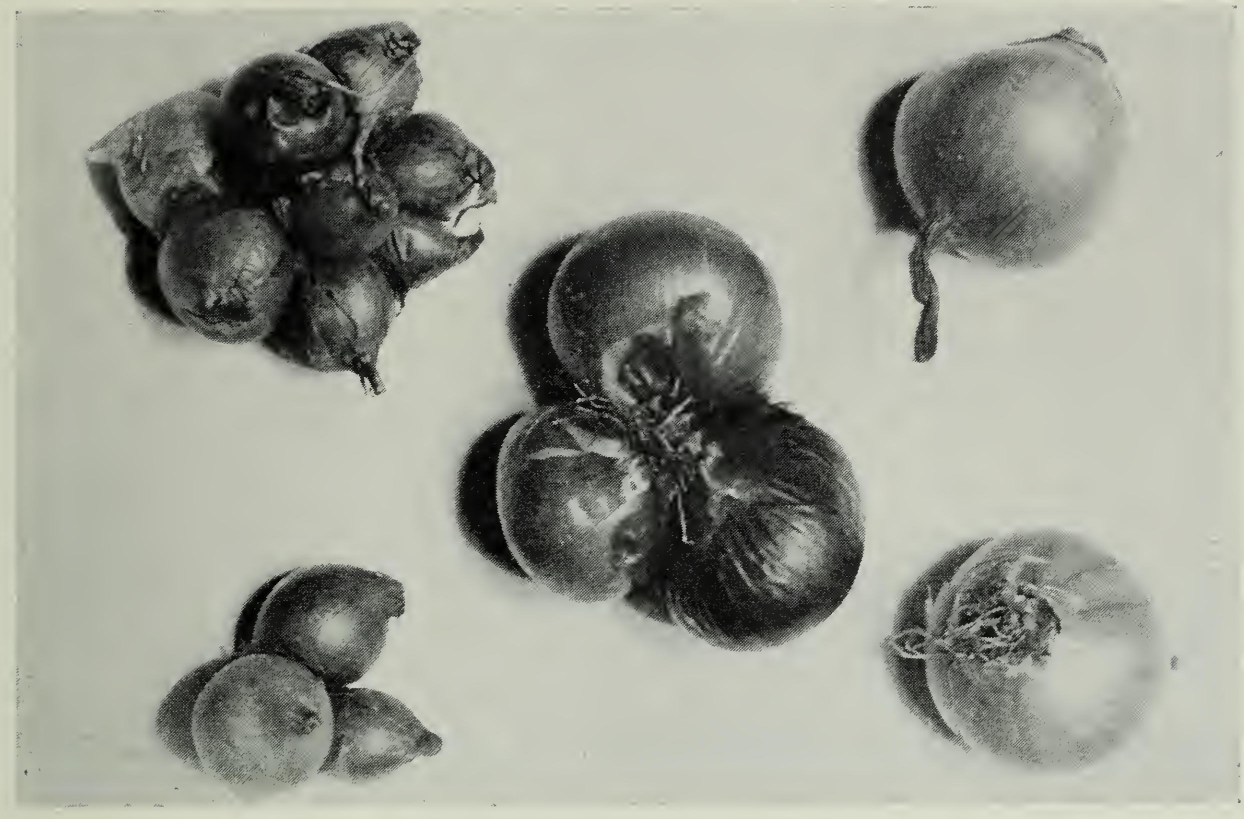


FIG. 18. Multiplier or potato onion.

CULTIVATION AND WEED CONTROL

Excessive and deep cultivation should not be practised as the root system of onions is shallow and the distribution of their fibrous roots is limited. Cultivation should be done only when necessary to control weeds and to avoid a serious soil crust.

The removal of weeds from the rows in an onion field is a very laborious and costly operation and may constitute the major item of the cost of production. But to produce a good crop of onions it is essential that weeds be kept under control as the nature of the onion root system is such that it cannot compete for food and moisture with a large number of weeds. This is especially true during the early stage of growth as the onions grow more slowly than the weeds. If the first flush of weeds is removed in time, either by hand or chemical means, later weedings will be successively easier.

Hand Weeding

Much of the weeding of onions is done by hand, and it is exacting work. It should be done when the weeds are small. Large weeds, when pulled, will greatly disturb the soil about the onion roots and bring weed seeds to the surface where they germinate. The weeds also compete for food and moisture.

When the soil is moist and cloudy weather prevails, weeds must be removed from the field, particularly on muck soil, as many of them will root again and grow. Since hand weeding involves crawling between the onion rows, considerable damage may result to the succulent, vigorously growing tops.

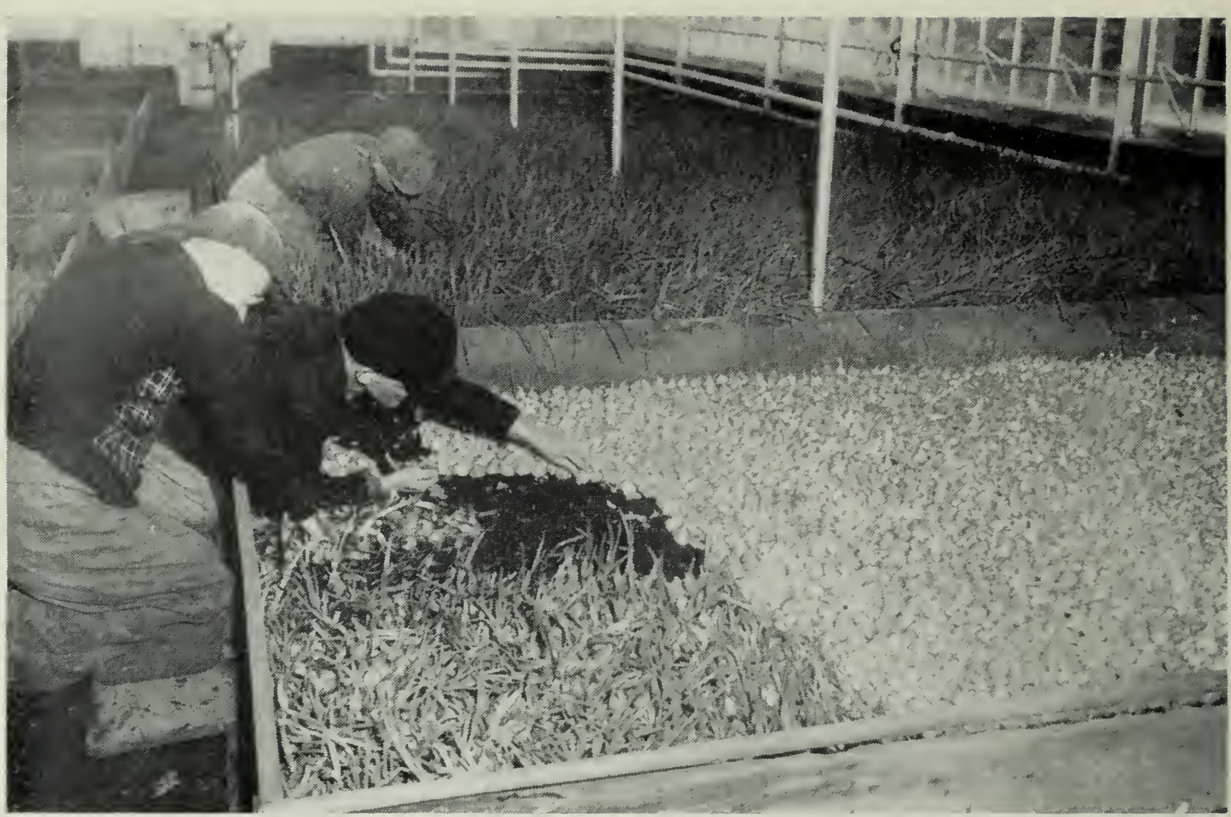


FIG. 19. Planting bulbs in a greenhouse for the production of green-bunch onions.

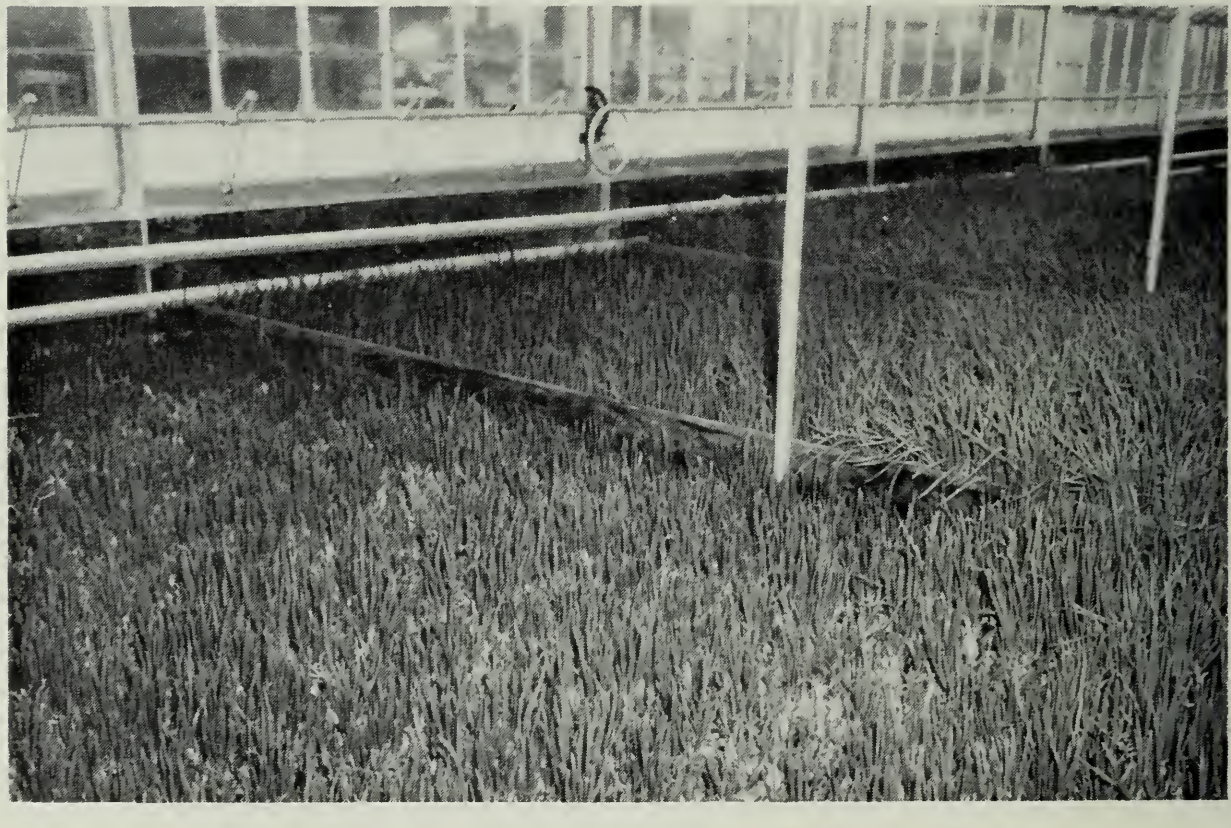


FIG. 20. Green-bunch onions growing from bulbs in a greenhouse.

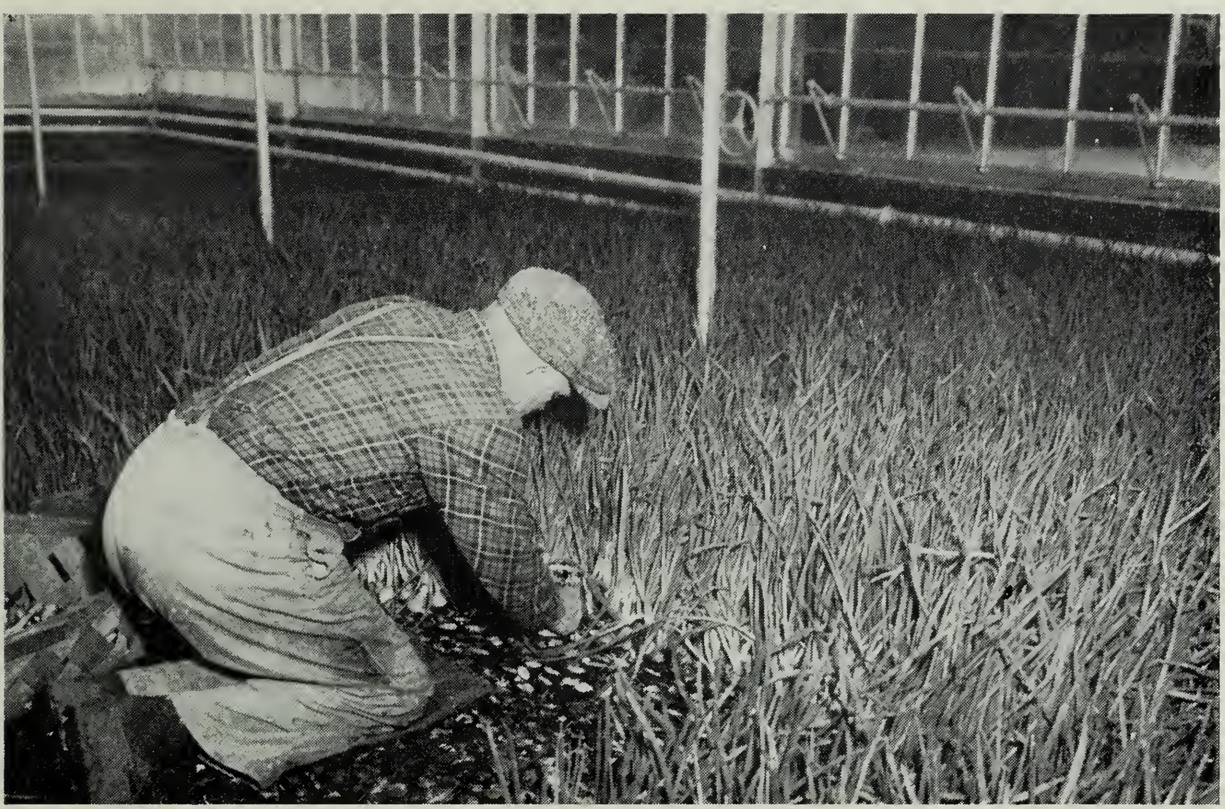


FIG. 21. Harvesting green-bunch onions from bulbs forced in a greenhouse.

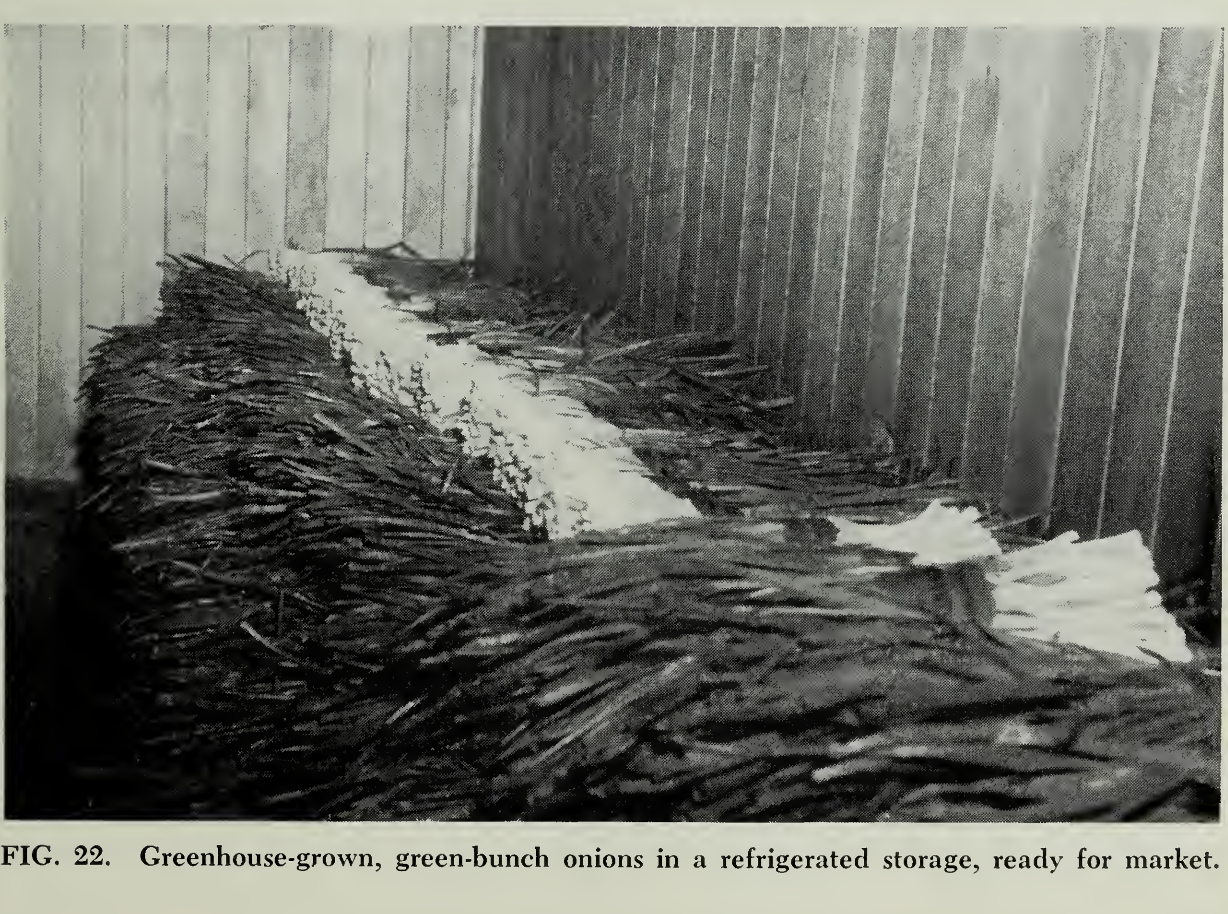


FIG. 22. Greenhouse-grown, green-bunch onions in a refrigerated storage, ready for market.

FIG. 23. Hand weeding is slow and laborious.

Chemical Weed Control

Recently, chemicals have been developed which can be used effectively to control weeds in vegetables. At the present time, chemicals should not be considered as a means of replacing sound cultural practices, but rather as adding another highly efficient weapon to fight the weeds.

For efficient control of weeds, proper pre-emergence, pre-emergence contact, and post-emergence applications of chemicals should be made. *Pre-emergence* control may be defined as an application of a chemical to the field to kill germinating weed seeds before the vegetable crop or the weeds have emerged. *Pre-emergence* contact refers to the application of a chemical to control weeds that have emerged in advance of the crop seedlings. *Post-emergence* application of a chemical is one that controls weeds after the crop has emerged.

The pre-emergence treatment eliminates most of the first flush of weeds. Thus this treatment greatly influences the efficiency of any future weed control program. In general, and particularly in vegetable crops, the weeds should be *small* for efficient control by means of chemicals. With onions, the weeds should be in the cotyledon stage of growth, that is, the first two leaves which appear after germination. A weed with over two true leaves is more difficult to kill.

The materials recommended are the Stoddard Solvent type of oil, or calcium cyanamid in either the granular or dust form, for the pre-emergence treatment; and potassium cyanate for the pre-emergence contact and the post-emergence treatments.

Calcium Cyanamid

Calcium cyanamid special grade dust applied to the soil before the onion seedlings emerge, at the rate of 75 to 100 pounds per acre, does a very efficient

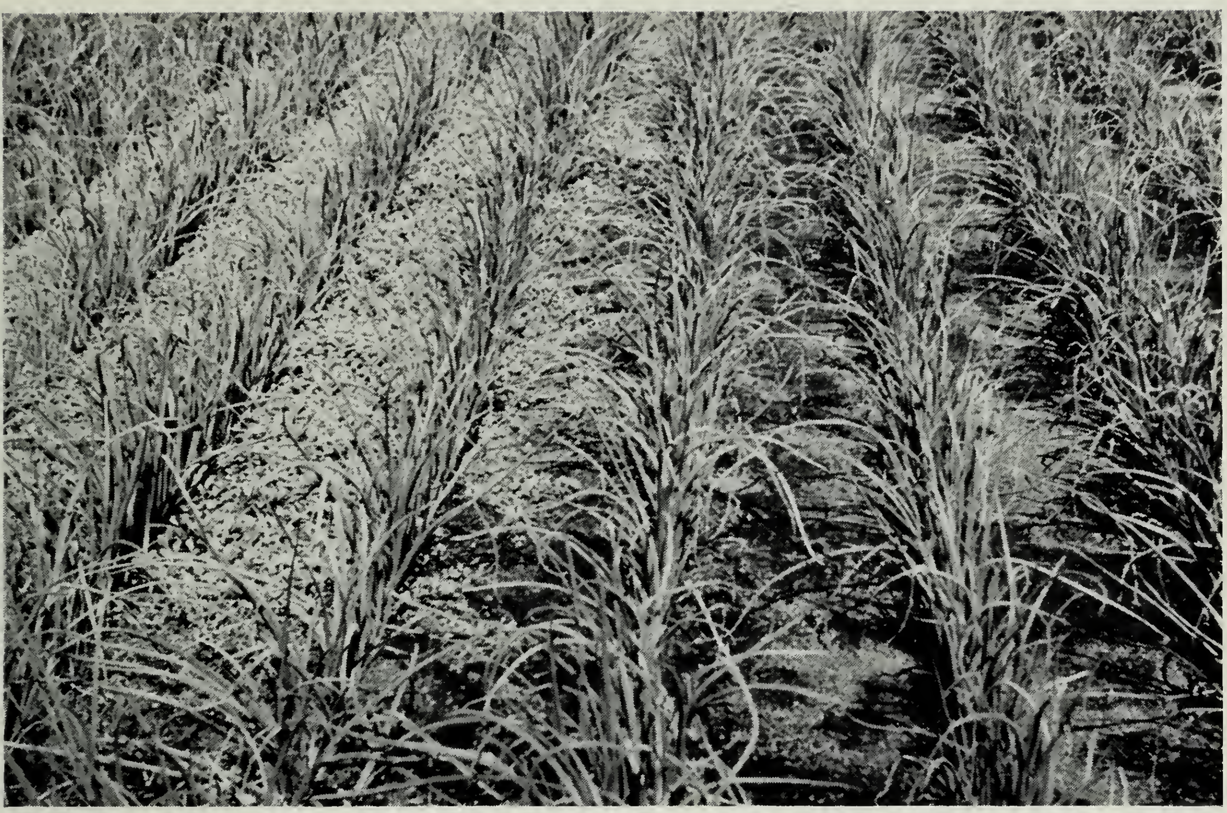


FIG. 24. Weedy rows (left); treated with potassium cyanate (right) while the weeds were small.

job at a fairly low cost. If the granular cyanamid is used, the seedbed should be finely prepared as lumps in the soil will cause the granules to roll to one side. The rate of application for the granular type is approximately 150 pounds per acre.

Stoddard Solvent

The Stoddard Solvent type of oil (dry cleaning fluid, mineral spirits, and paint thinner) may be applied to the whole field, or as a 3- or 4-inch band down the row, before the onions emerge. Twenty to 30 gallons, undiluted, are necessary per acre when a 3- to 4-inch band is sprayed. After the onions emerge from the soil, Stoddard Solvent should not be applied as injury or death to the plants will result.

Potassium Cyanate

Potassium cyanate (KOCN) is applied as a spray for pre-emergence contact and for post-emergence treatment as a selective weed killer. Lamb's-quarters and certain species of grass are fairly resistant to this material.

The pre-emergence contact spray is applied at the rate of 8 pounds, or up to 12 to 16 pounds, of potassium cyanate in 50 gallons of water per acre. For the post-emergence application, 8 pounds of potassium cyanate in 50 gallons of water may be applied per acre. If the rows only are sprayed in a 4-inch band, proportionately less material than mentioned previously should be used.

The weeds should be dry, as moisture on the leaves will dilute the spray and promote easy runoff. The spray should be applied when at least 4 hours of dry weather is anticipated. Warm weather hastens the weed kill. It is important to mix a fresh solution for each application, as the material in solution will break down in a short time and become ineffective. Onions damaged by frost, hail, wind, drought, insects, or diseases show severe tipburn and should not be sprayed with potassium cyanate until normal growth resumes. If a treatment should fail for any reason to give good control of the weeds, a period of 3 to 4 days should elapse before repeating the application; an earlier repeat application may damage the onions.

Sulphuric Acid

At certain stages of growth and under certain weather conditions, dilute sulphuric acid (2½ per cent by volume in water) has given satisfactory control of weeds without damaging the crop. However, the results obtained in the past have been very erratic.

IRRIGATION

Irrigation is very profitable, especially during hot, dry periods on the lighter mineral soils and on muck soils. Onions should receive only as much water as is necessary to keep them growing vigorously. When the crop is approaching maturity the moisture supply should be gradually decreased so that the bulbs will ripen well. If the crop is irrigated within 2 to 3 weeks of harvesting time, immature and thick-necked bulbs are likely to result.

On muck it is very important to maintain a water-table that is at least below the surface of the soil. Otherwise, swelling of the bulb is delayed, and this results in the formation of a large proportion of thicknecks. Also, the water-table should remain at a fairly constant level during the growing period so that the roots may become adjusted to the supply. However, for a short period before harvesting, the soil should be gradually drying out to ensure proper ripening.

HARVESTING

The harvesting of green-bunch onions has been discussed previously for each method of production. In general, when green onions are the diameter of a lead pencil, and up to when a small bulb is formed, they are pulled, trimmed, and bunched for immediate sale.

With mature-bulb onions, weather and soil conditions must be right for proper ripening in the field and careful handling must be given from the time the crop is ready to harvest until it reaches the consumer. The discussion which follows refers to the mature-bulb crop.

Ripening and Maturity

A well-matured bulb is one which is firm and with the shape and colour typical of the variety. Maturity is evidenced by the neck tissues beginning to soften, the tops starting to fall over, and the roots beginning to die. During this stage of development, and for a time thereafter, food material from the leaves is rapidly transferred to the storage leaf bases. This food transfer results in a rapid increase in bulb size.

If the tops, while standing erect, dry from the tips toward the base, the neck does not close properly. Such onions are called scallions or thicknecks. They do not store well. Scallion development is due, in large part, to excessive nitrogen. Experiments have shown that either breaking or rolling down the tops or cutting the roots has little effect in hastening the maturity of the crop and may reduce the yield and keeping quality.

Late-maturing onions usually sprout more readily than early-maturing onions. Also decomposition of the bulbs in storage is greater in the late-maturing onions.

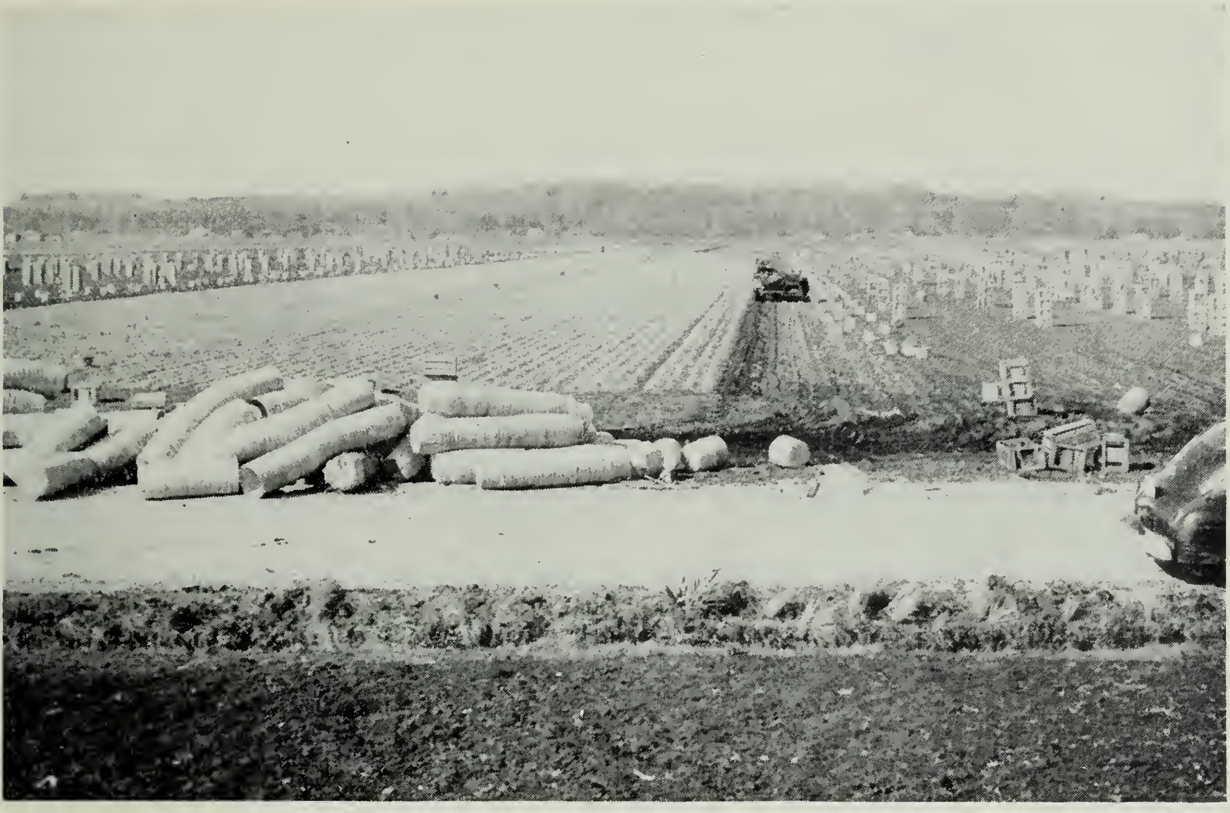


FIG. 25. An onion combine lifting, topping, and placing onions in slatted boxes for field curing.

Pulling

Onions that are to be stored keep better if they are fully ripe before being pulled. Fully ripe onions are characterized by dead and shrivelled tops and a dry outer skin of the bulbs. However, lifting or pulling the crop is usually done when about two-thirds of the tops in the field have become soft at the neck and fallen over. Some reasons for not waiting until the later fully ripe stage are: if heavy rains occur during the ripening process there is danger of second growth; orderly marketing of the crop is essential to advantageous prices and to keep the steady customers supplied; and with a large acreage, it is necessary to start harvesting in time to complete the work during favourable weather.

Pulling is done either by hand or by machine. When the bulbs have matured properly, hand pulling is fairly easy, providing the soil is not hard or compact. Machine lifters are desirable when a large acreage is to be pulled. Onion combines will lift, top, grade, and bag the bulbs in one operation.

Curing

Well-cured onions are hard and the necks are not easily dented by thumb pressure. The curing process is completed after pulling and is accomplished by placing the bulbs in windrows in the field or in open-mesh bags or crates either in the field or under cover.

In one method of curing, 4 to 6 rows of onions are pulled and put into a windrow so that the tops of one onion cover the bulbs of another onion in shingle fashion. The tops provide partial protection from the sun and from frost. Bulbs that lie exposed may be sunburned or frozen. If rain occurs during the curing period in windrows it is wise to turn the onions; otherwise the bulbs may

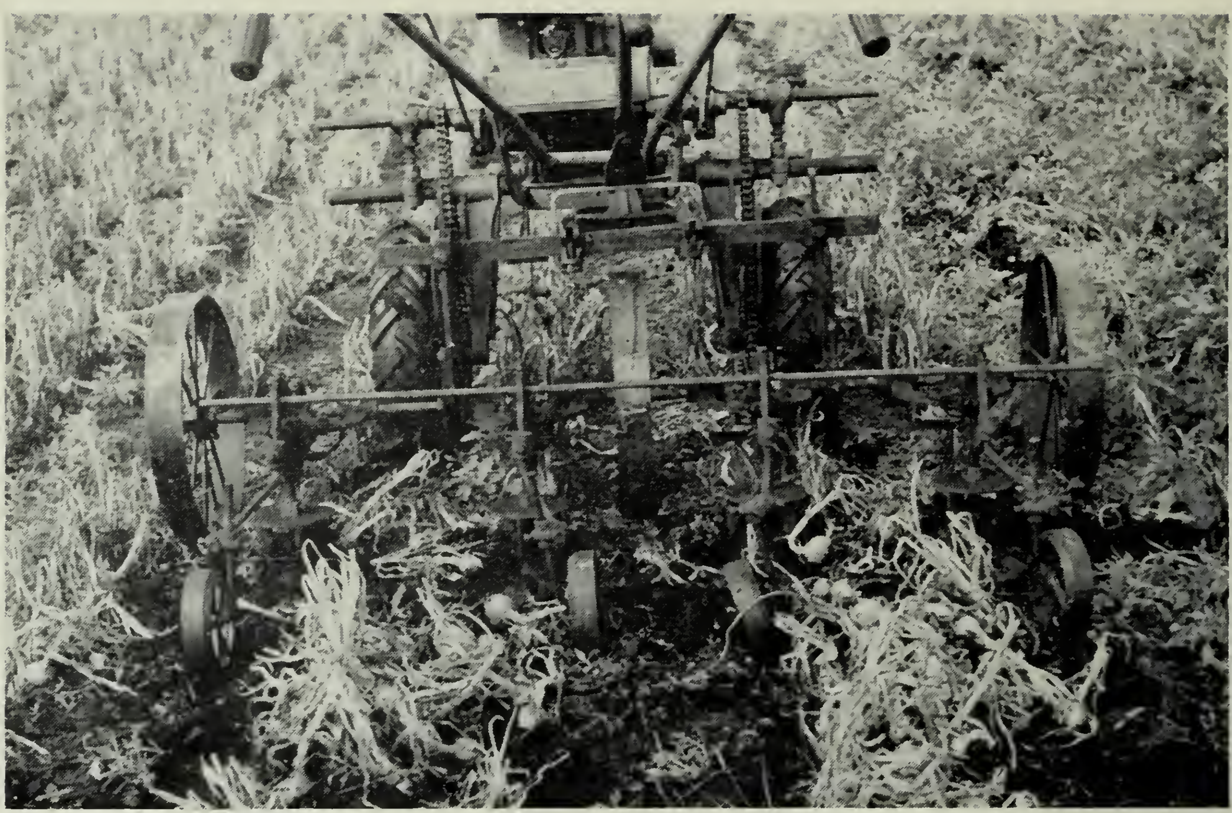


FIG. 26. A mechanical onion-lifter attachment for a small garden tractor.

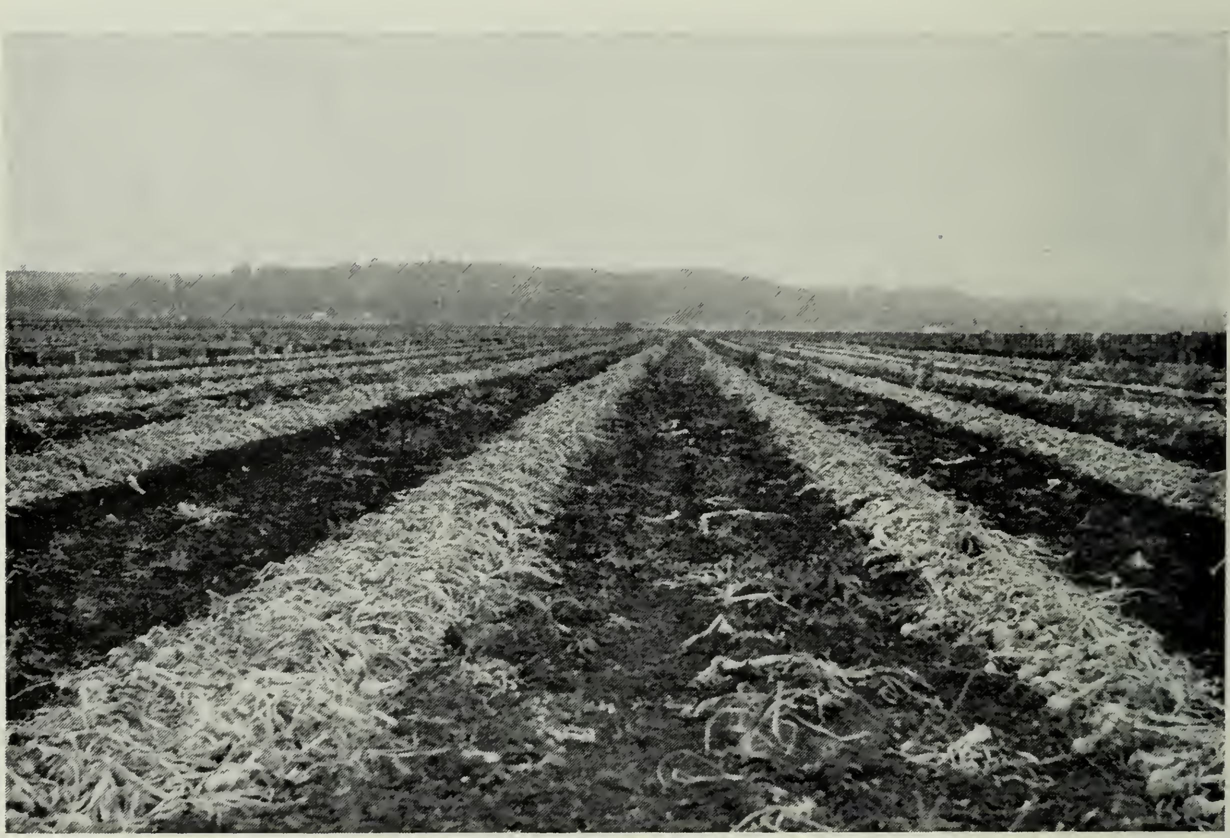


FIG. 27. After pulling, onions are placed in windrows to start the curing process. The tops cover most of the bulbs and thereby prevent sunscald and frost injury.

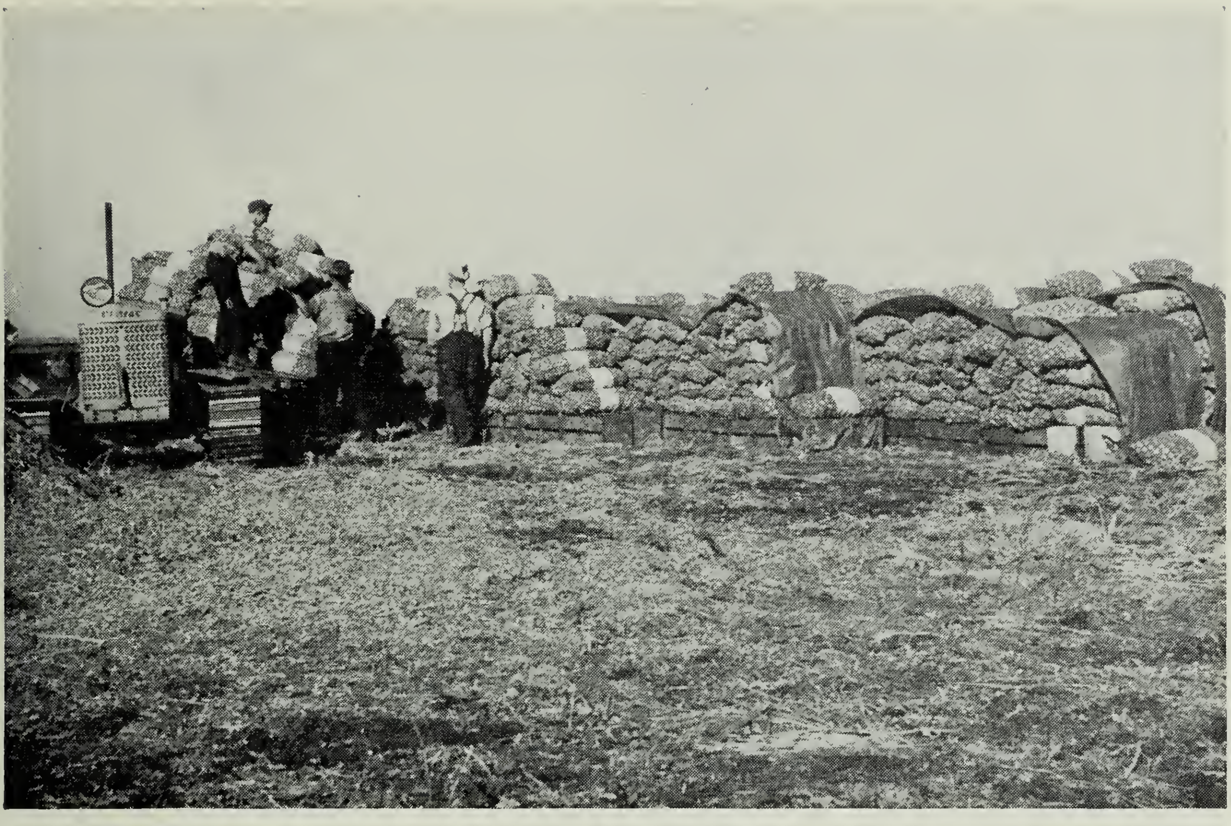


FIG. 28. Fifty-pound bags of onions piled in the field to dry and to complete the curing process after topping. These onions are intended for immediate sale or short-term storage.

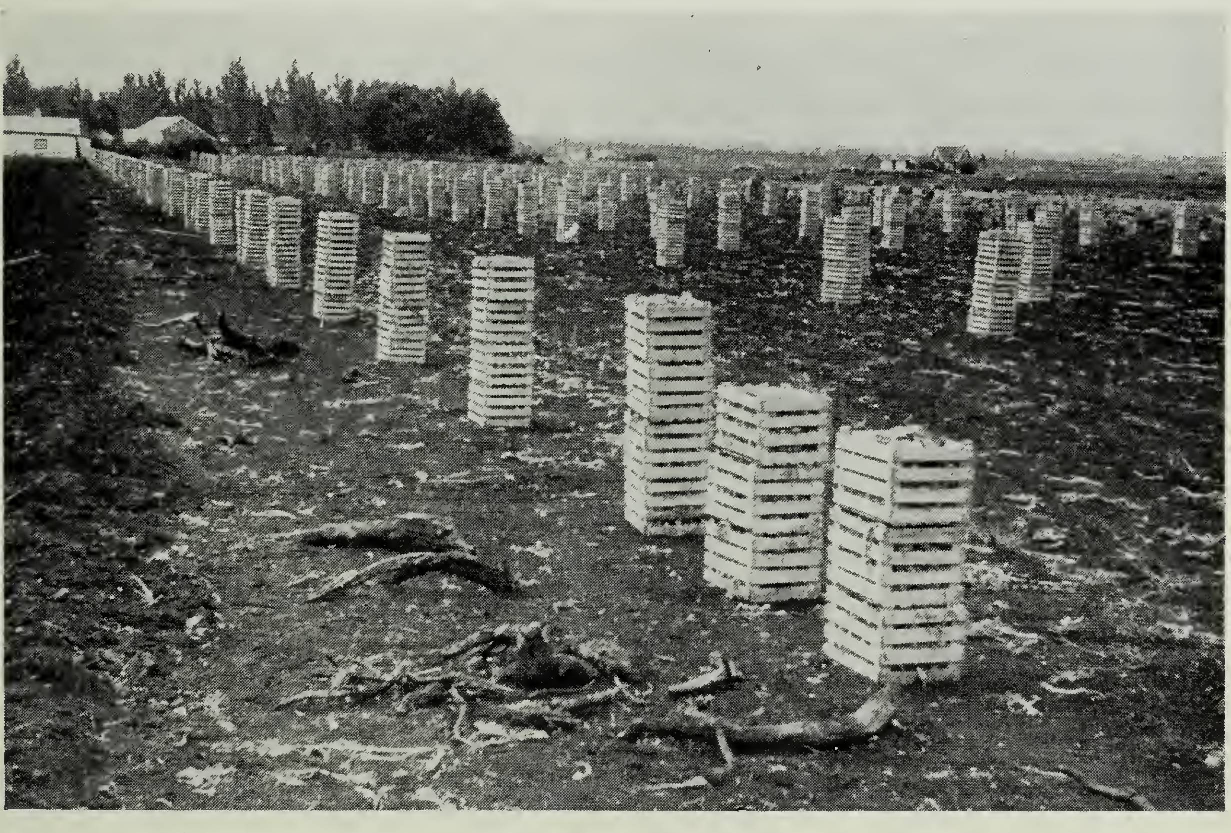


FIG. 29. Field curing of onions in slatted crates. This method is suitable in handling onions for long-term storage.

become discoloured, begin to rot, or start to grow. If the weather is warm and dry, the curing process may be completed in 7 to 10 days. The onions may then be gathered and topped.

When open-mesh bags or crates are used, the tops are removed before the bulbs are placed in the containers. The open-mesh bags should be raised off the soil and placed upright.

Slatted bushel crates are excellent containers in which to cure onions. The crates are stacked in single piles about five crates high. This allows free circulation of air around and through the onions. Canvas or building paper is placed on the top crate to protect the bulbs from sun, frost, and rain. The crates of onions are usually left for 2 to 3 weeks, depending upon weather conditions.

Discoloration of the scales of white onions often occurs with field curing. For this reason curing under cover is preferred.

Topping

Onions may be topped by hand or by machine. The method of topping employed depends largely upon the size of the field. Hand topping by twisting the tops off possesses the merit of leaving the scales closed tightly at the neck of the bulb. When the tops are removed by cutting, the scales may be left open and thus allow the entry of decay organisms.

Whatever method is adopted, the tops should be removed ½ to ¾ of an inch from the top of the bulb. This is the position where the tops normally bend over when mature.

Very careful handling of onion bulbs is important for all operations from the time they are lifted until they are consumed. Onions bruise easily and bruises are often the cause of deterioration in storage. Mechanical toppers if run at excessively high speeds will bounce the bulbs and thus cause injury. Improperly adjusted mechanical toppers often cut the tops off too closely, thereby tearing or peeling the bulbs.

Grading

Onions are graded according to size and quality. A high-quality pack is obtained by eliminating immature, decayed, sunburned, and mechanically injured bulbs, double bulbs, and bulbs that have started a second growth. When mechanical toppers are used, graders are often attached to divide the bulbs into the various sizes required by the trade and to eliminate the off-grades. Those bulbs that are not sold by about December are usually re-graded in storage to remove early sprouters and decayed onions.

Storage

The market generally cannot absorb the entire crop during the harvest period, hence adequate storage space must be provided. Many onion growers store a portion or all of their crop in garages, under tarpaulins outdoors, and in various kinds of temporary quarters. When the danger of heavy frosts comes in the fall these growers must look for a quick sale because otherwise the bulbs may be frozen. Distress sale results in a disorderly market with a resultant drop in prices. By placing part or all of their crop in proper storages, the growers can market their onions in a more orderly fashion during the winter and early spring.

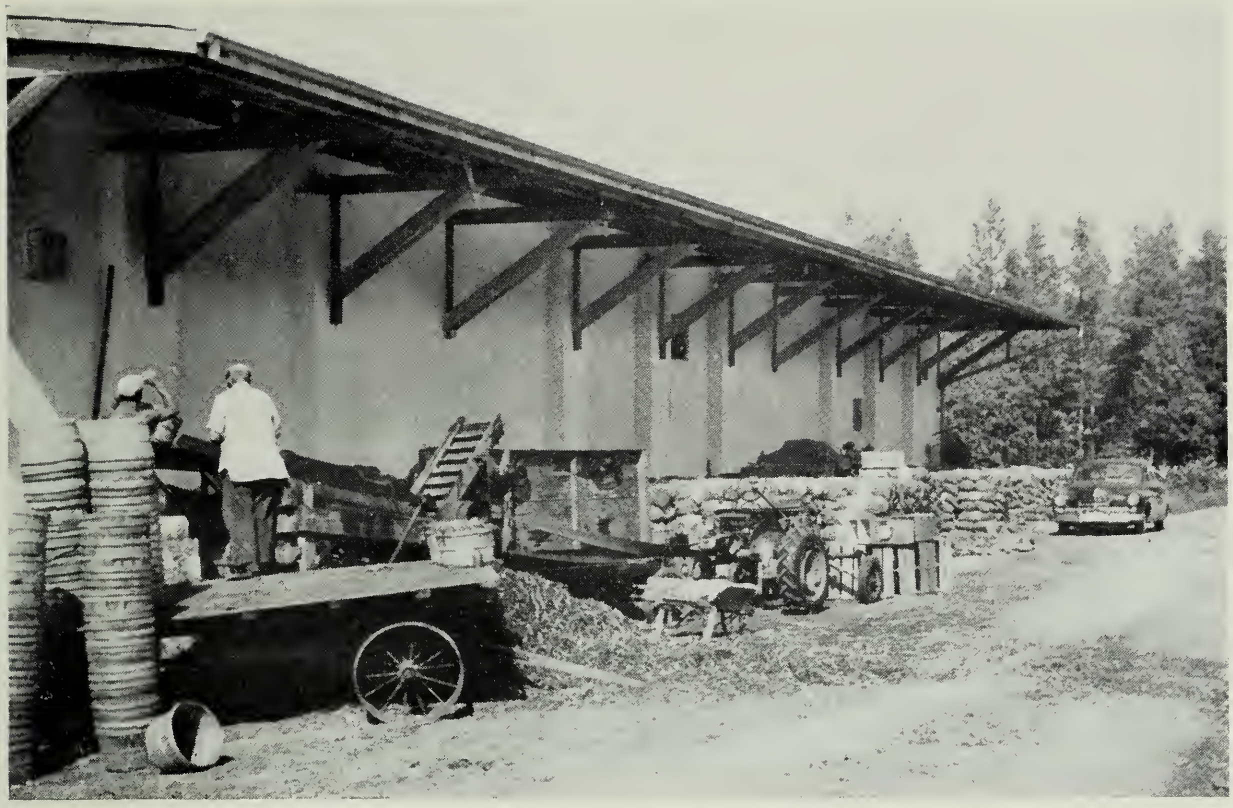


FIG. 30. A common storage with thermostatically controlled intake of air.

Onions store best when cool, dry conditions, and good circulation of air are provided. The maturity and handling methods, of course, have a direct bearing on the length of time onions can be stored without loss of quality.

Temperature

The ideal storage temperature is 31° to 32°F. Onion bulbs and sets freeze at 30.1°F. If freezing should occur in storage the onions should be gradually thawed out at about 40°F. Alternate freezing and thawing is very injurious.

Bulbs which have matured well and have been properly cured soon enter into a rest period of approximately 2 months. The higher the temperature becomes after the rest period, the greater will be the loss from sprouting. Therefore, as low a temperature as possible without freezing should be maintained.

Humidity

A fairly low relative humidity of around 64 percent largely prevents the growth of roots and checks the spread of rots in storage. However, the rate of softening and shrinkage of the bulbs is increased. Higher relative humidities seem to be satisfactory if a constant temperature of 32°F. can be maintained.

Sprout Inhibitors

Certain sprout inhibitors, such as maleic hydrazide, have shown some promise to lengthen the storage period. They may be of special value for the early maturing, normally short-keeping varieties and the present hybrids. However, this subject is still in the experimental stage.

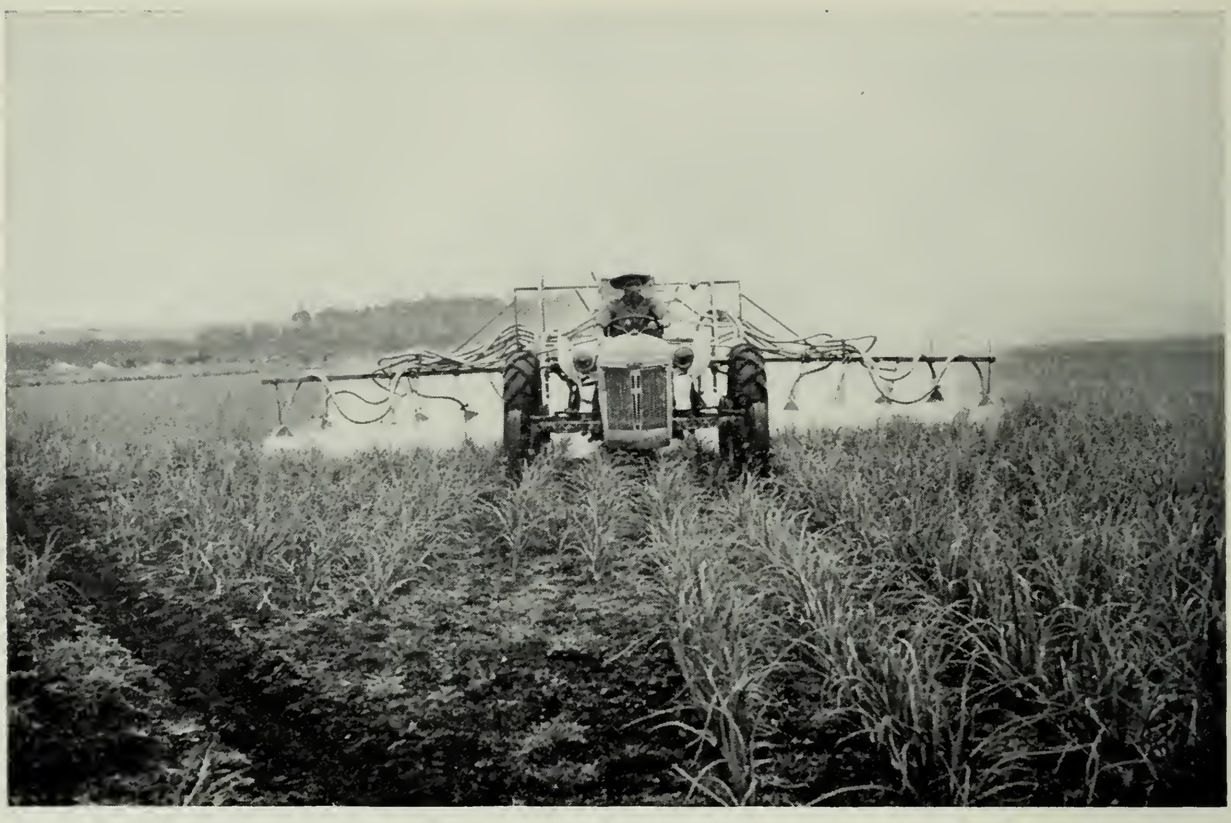


FIG. 31. Dusting is one means of controlling diseases and insects.

Storage Structures

Common storages that are sufficiently insulated and equipped with thermostatically-controlled, forced-air circulation, possess advantages for the storage of onions. Another type of onion storage employs forced circulation and ventilation when the outside air is dry, or uses heated and dry air if the outside temperature is below freezing. The blower fans direct the air under the piled crates, through the onions, and out the ventilators in the roof. Refrigerated storages provide a more uniform temperature throughout the storage life of the bulbs. Since the refrigeration coils collect the moisture, it is probably easier to maintain the desired low relative humidity than is the case in common storage.

INSECT AND DISEASE CONTROL

For information on insect and disease control in onions consult the "Protection Calendar for Vegetables", which is published by the Fruit Branch, Ontario Department of Agriculture.

Agawam

Concord

Seibel 9110

BULLETIN 487 JUNE, 1952

THE GRAPE
IN ONTARIO

●

HORTICULTURAL EXPERIMENT STATION
VINELAND STATION, ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

LOCATION, SITE, AND SOIL 3
Location 3
Site 3
Soil 4
PLANTING 4
Preparation of the soil 4
Nursery stock 4
Propagation 5
Direction of rows 5
Distance of Planting 5
Marking the field 6
Setting the vines 6
CARE OF THE YOUNG VINEYARD 7
THE TRELLIS 9
Post and bracing 9
Wiring 9
PRUNING, TRAINING, TYING 15
Pruning 15
Systems of training 15
Time of pruning 17
Relation of cane diameter to fruitfulness 17
Number of buds per vine 17
Pruning the French Hybrids 18
Renewal spurs 18
Renewing old vines 19
Tying the vine 19
Suckering 20
Summer pruning or topping 20
VINEYARD SOIL MANAGEMENT 20
Cultivation 21
Green-manure crops 21
Fertilizers 22
HARVESTING 24
SELECTION OF VARIETIES 24
Approximate maturity dates for grapes 26
Grape survey 30
VARIETY DESCRIPTIVE NOTES 26
General list 26
European types 31
French Hybrids 31
INSECTS AND DISEASES 32
Grape leaf hopper 33
Grape berry moth 34
Grape flea beetle 34
Rose chafer 34
Downy mildew 36
Powdery mildew 36
Black rot 37
Dead arm 37
Chlorosis 38

THE GRAPE IN ONTARIO

O. A. BRADT

The grape is an important fruit crop in Ontario consistently ranking with the apple and the peach in revenue to the grower. The acreage of grapes has at least doubled in the last twenty-five years, now (1951) being variously estimated up to 21,000 acres. In 1950 the largest crop in the history of the industry was harvested, 53,865 tons. Grape growing is concentrated in the counties of Lincoln and Wentworth in the Niagara Peninsula, with Welland, Halton and Kent growing a small portion of the total crop. The present bulletin is an attempt to keep the grape grower informed on the most recent information on grape culture and varieties as adapted to Ontario conditions.

LOCATION, SITE AND SOIL

Location

Grapes thrive fairly well without winter protection throughout most of southwestern Ontario. However, the most favorable areas are those where the winter temperatures are moderated by the influence of Lakes Erie and Ontario, and summer temperatures are high. The grape likes heat.

The general location for grapes is of great importance. In the Niagara peninsula, where most of the grapes are grown, the general aspect is north, facing Lake Ontario, with the escarpment or "mountain" in the rear. Here the crop varies from season to season, but is never a complete failure. The most favored locations are back from the lake shore, just below and on the first rise of the escarpment where, depending somewhat on the direction and force of air currents, spring and summer temperatures are often several degrees higher than close to the lake.

In some seasons the fruit fails to fully mature in lake-shore vineyards where the cooling effect of the water delays the start of spring growth and tempers the heat of summer. On the other hand, the lake influence sometimes prevents injury from late spring and early fall frosts, vineyards above the escarpment being especially subject to such injury. Delayed maturity becomes a matter of utmost concern in seasons such as 1950 when even the most favorably situated vineyards barely matured their crops. In locations where the growing season is consistently short only early maturing varieties should be planted.

Site

The site for a vineyard should be chosen with particular regard to air circulation and soil drainage. Good air circulation will aid the grower in his fight against mildew and rot. The danger of frost injury in the spring and fall depends largely on site. Low-lying, flat land suffers first as cold air tends to settle there, flowing down from higher ground.

As to soil drainage, a very slight slope is sufficient to carry away surface water. Too great a slope is a definite disadvantage in that soil erosion may be severe.

Internal drainage of the soil will depend on its nature, the heavier the soil the poorer the natural drainage, particularly where the subsoil also is heavy. Since many of the best grape soils are clays, underdrains are often advisable. Subsoiling in late fall will help break up the subsoil, and improve drainage.

Soil

Grapes are grown successfully in a commercial way on a great variety of soils. Good vineyards are found on the clays of Vinemount, Beamsville, and St. Catharines; the mountain wash of Winona; the black soils of Homer; the sandy soils of Jordan, Vineland, and Port Dalhousie; the sand of Fonthill; and the gravel in the Burlington district. However there are general soil preferences, and individual varieties show preferences noted in the variety discussion.

The site has been mentioned as influencing maturity of the fruit. A cold soil also delays ripening, the coldness being due largely to an excess of water in the subsoil. Grapes thrive best on the drier, warmer soils where the fruit matures early, with relatively high sugar content and therefore improved quality. It is better to plant at the start, on the heavier, harder clays, except perhaps those few varieties which prefer a sandy soil.

Two types of soil give large crops of high quality grapes. These are the silty soils found below the escarpment in the Niagara Peninsula, and the soils of the first ledge of the escarpment. The former is a gray or black colour, from 6 to 9 inches deep, and underlaid with a heavy subsoil of bluish, or drab-coloured clay. Where the proportion of organic matter is greatest, the soil is darkest and most open and friable. This type of soil is derived from glacial lake deposits and occupies low-lying areas.

The soil in the first ledge of the escarpment is dark brown to grayish brown clay and clay loam, about 8 inches in depth, somewhat hard and cracks on drying. Owing to its nature it usually drains easily, as the grit and gravel, well mixed with the greater part of the soil, tend to keep it loose and open. The subsoil however is hard and impervious to water. The exception to these two types of grape soils is found in the warm, dry sands of the Fonthill district in particular, and scattered elsewhere.

In the Niagara district, grapes are often planted on the poorest soil on the farm — heavy, poorly drained, shallow, often low, and flooded in the spring. This is not because grapes prefer such soil but because they will withstand these conditions better than any other fruit crop grown in the district.

PLANTING

Preparation of the Soil

Thorough preparation is necessary. Where land has been in sod for a number of years it may be worked and a green manure crop sown the year before planting, or a hoe crop may be grown. Where an old vineyard is to be replanted working it up and seeding down to a good sod for two or three years would be a distinct advantage. Just before planting the vines, work the land well.

Nursery Stock

If one-year vines are to be planted, they must be of good size, otherwise two-year vines are to be preferred as they have a larger root system and will produce more vigorous growth in the first season.

Frequently not enough importance is attached to obtaining first-class stock as the lower price of the poorer grades is tempting. However, the eventual success of the vineyard will depend in considerable measure on the excellence of the planting stock.

As soon as the nursery stock arrives, the bundles should be opened, the vines spread out, and heeled-in in some sheltered spot. Care must be taken not to mix the varieties. Notify the nursery immediately of any errors in the order so that replacements may be made without delay.

Propagation

Some growers prefer to raise their own plants. Grapes are propagated quite easily from hardwood cuttings if certain precautions are observed. Cuttings may be taken any time the vine is dormant but if they are taken during November and December there is less likelihood of the canes having winter injury.

Well-matured canes of the past season's growth are used. Three-bud cuttings are best, the nodes being sufficiently close together that the cuttings are not longer than ten inches. In preparing the cuttings, a cut is made about one-half inch below the basal bud and one or two inches above the top bud. This method of cutting distinguishes the lower end which is to be placed in the ground. For convenience in planting, all cuttings should be placed the same way in the bundle. Bundles of fifty to a hundred make handling easy.

Cuttings may be stored in a cool, moist place until time for planting in the spring. Moist sawdust, sand, and peat moss are satisfactory packing and storing materials. Unless the cuttings can be stored in a cool place a well-drained outdoor pit may prove more satisfactory. A sandy or sandy loam soil is best but if heavy soil only is available moist sand may partially fill the pit. The cuttings should be placed so they will be covered with at least three inches of sand or sandy soil which should be pressed firmly all about them. A heavy straw mulch should be placed over the cutting bed.

The cuttings are planted in a nursery row as early in the spring as is possible to work the soil. For planting, a furrow should be made deep enough that most of the cuttings can be planted in a vertical position with the top bud just at the normal soil level. If some of the cuttings are too long they may be slanted slightly. Rows should be 3 to 4 feet apart with the cuttings 6 to 8 inches apart in the furrow. The firm packing of the soil about the cuttings is very important. Thorough cultivation during the growing season is required for maximum growth.

Other methods of propagation are by layering, grafting and top-working but these are not common.

Direction of Rows

Rows usually are run north and south to get the maximum amount of sunlight on the vines. However, where there is more than a slight slope the rows should be run across the slope in order to reduce erosion to a minimum. A little wider spacing might be justified when the rows run east and west.

Distance of Planting

Planting distances vary a great deal throughout the grape district, from 9 by 12 feet to as close as 7 by 10 feet. Vines planted on the lighter, sandy soils require more feeding space than the same varieties planted on clay. Also, varieties such as Niagara and Concord are far more vigorous than Delaware, for example, and must be farther apart in the row since they require "longer" pruning. For such vigorous varieties a distance of nine feet between the vines is recommended.

The minimum distance between the rows has been practically fixed at ten feet, the smallest space for servicing the vineyard to advantage with most modern equipment. Up to twelve feet may be needed for large tractor implements, manure spreaders, etc.

When the vineyard is to cover a considerable area it is best to provide alleys crosswise to the rows. These will facilitate such operations as spraying and harvesting. Alleys should be wide enough to permit easy turning with tractor implements.

Marking the Field

Previous to planting, the vineyard must be staked to show the location of the rows. Care must be taken to have rows straight to make easy all subsequent vineyard operations. Ordinarily a plow is used both to mark a straight row and to prepare a furrow for planting. As deep a furrow as possible is made the first time, and then by returning in the same furrow it can be made about 10 to 12 inches deep, or sufficient for the vines. Where the soil is shallow, it may be necessary to dig all holes, using the plow for marking only. Some growers prefer this method as it provides more room for spreading the roots when planting.

As soon as the first furrow is ready, planting may begin. A rod cut to a length equal to the distance between the vines is convenient for marking but must be used carefully so that the vines line up crosswise.

In large plantings a better system is to measure in a row of stakes at the proper distance for individual vines, a few feet from the first row, where they can remain undisturbed. Other rows of stakes are measured in about every tenth grape row. With these stakes as guides a wire attached to two heavy stakes is stretched across the furrows and pulled tight. The position of each vine in each furrow is then quickly marked. This method of course necessitates the striking out of several furrows before planting is started.

Setting the Vines

Vines may be planted in late fall or early spring with equally good results. If planted in the spring, the earlier the better, as this enables them to become well established before the heat of summer.

The young vines should be pruned before planting. If the vine has several canes, all but one should be removed, and this one should be shortened to two buds, although, for convenience in planting, this cane may be left full length until the vine is set. This pruning makes the vine less liable to dry out before rooting, and gives fewer but more vigorous shoots. The roots may be cut back to facilitate planting, but otherwise they may just as well be left as they are.

In addition to the single two-bud cane a one-bud stub may be left as a convenient place to tie the grape vine when the vines are to be trained to the trellis in the year of planting. Tying the twine to the stub rather than the cane will avoid girdling as the cane increases in size.

One man usually does the planting, but in the case of large plantings two men are often used and a boy supplies them with vines already pruned. In planting, the roots should be spread out carefully and the earth firmly tramped over them. The vines may be set a little deeper than in the nursery row.

When vines are planted as replacements in old vineyards special attention is needed to give the young vine a good start. A large hole is dug and top soil placed in the bottom of the hole and around the roots of the young vine. A generous application of manure applied as a surface mulch will help the newly planted vine.

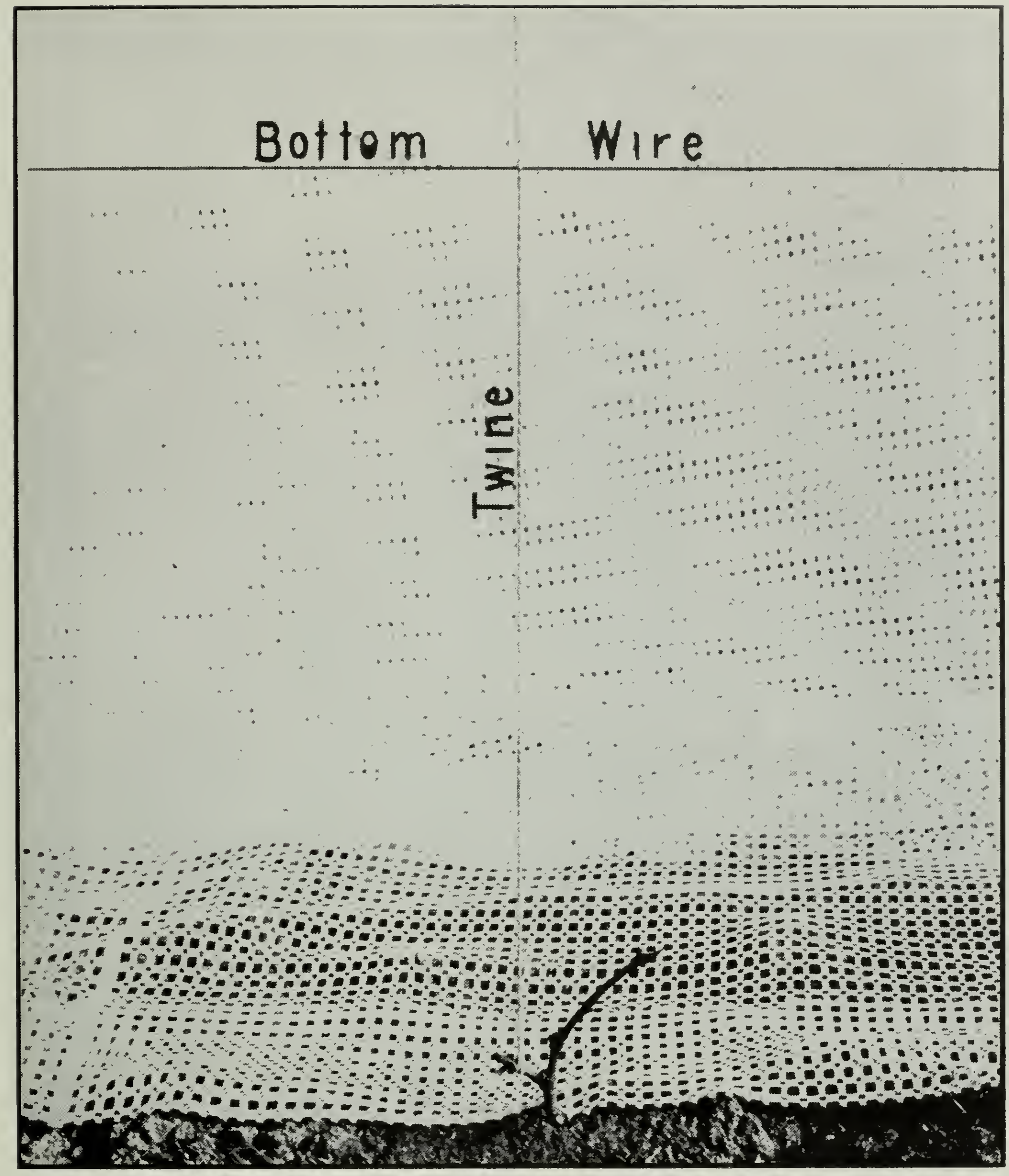


FIG. 1. Newly planted grape vine showing method of tying twine to a stub.

CARE OF THE YOUNG VINEYARD

If posts are set and wired soon after planting, the training of the vines can be started immediately. The young vines will be out of the way of implements and the vineyard is easily kept free of weeds, advantages which may outweigh spreading the expense of planting and posting over two years. Some growers use laths or steel tomato stakes to support the vines during the first season.

The newly set vineyard requires thorough cultivation during the first season. This may be given economically in conjunction with a companion or intercrop requiring clean cultivation, such as sweet corn or tomatoes.

In training the vine, a grape twine is tied tightly to the stub mentioned previously (Fig. 1). Usually both buds on the two-bud cane start growth. The weaker of the two should be removed when one to two inches long, together with any other surplus shoots that may come up.

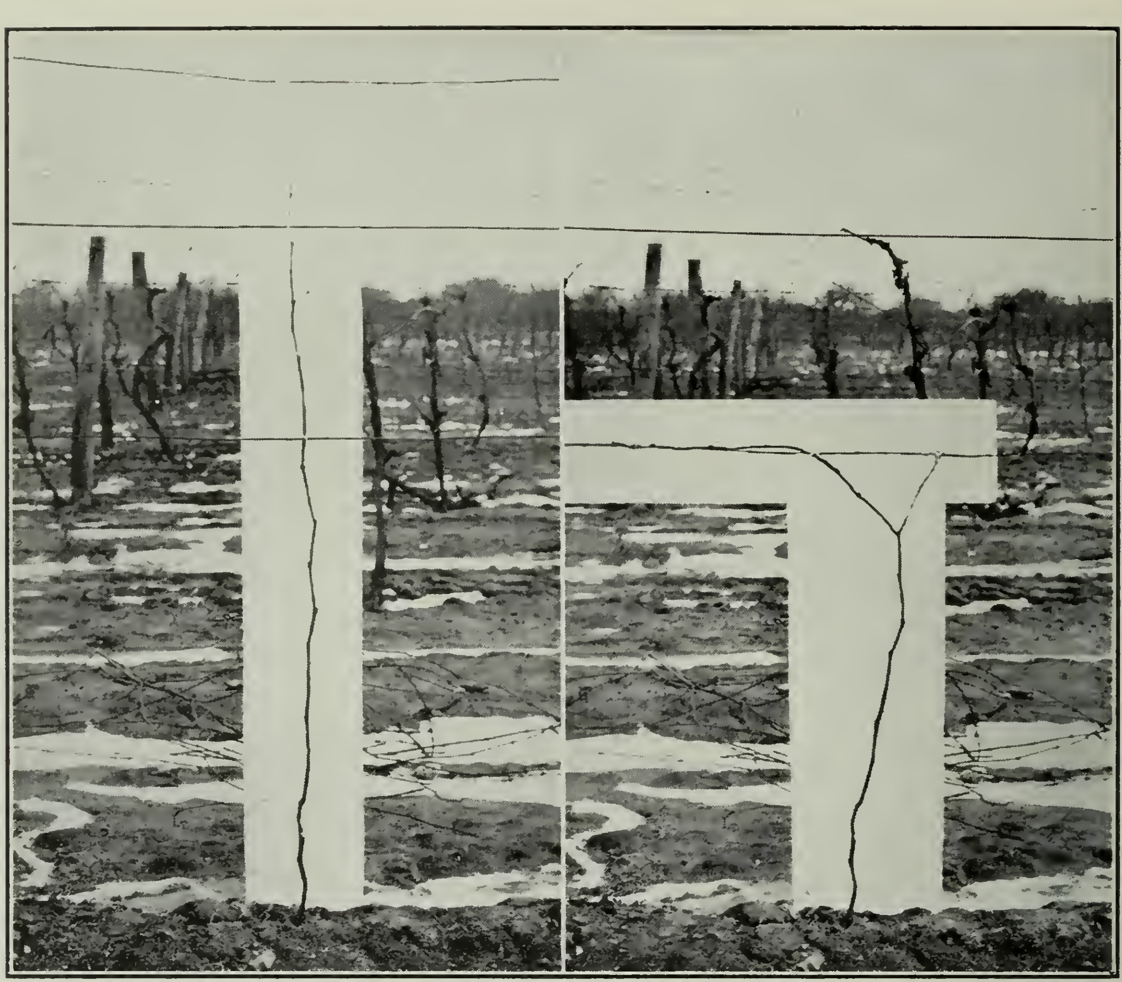


FIG. 2. Correct (left), and incorrect (right) method of tying the young plant after the first season's growth. In order to obtain a straight trunk, tie the selected cane to the highest wire it will reach. Heavy heading back at this time delays fruiting and accomplishes no useful purpose.

As the vine grows in length it is twisted loosely about the twine, this operation being necessary two or three times during the season. When the cane reaches the top wire, which may take two years, it should be cut off immediately above the wire and should be tied tightly to it. If the cane is too short to reach the top wire the first spring after planting, cut it off above the last good bud. Tie below this bud, draw the cane up tight and straight and tie to the top wire.

If the posts are not set the first spring they should be set in the fall so that the vines may be tied up the following spring before new growth starts. If the first season's growth has been very weak the vine may again be cut back to one two-bud cane and a one-bud stub. Many growers make a practice of cutting back to two or there buds at the end of the first season's growth, regardless of the amount of growth the vines have made. However, experimental work has shown that where good growth has been made there is nothing to be gained by this delay in training. In fact, fruiting is delayed without any compensating benefit to the young vine.

During the second season's growth it is advisable to remove all suckers and secondary shoots not needed to form arms. If the trunk below the lower arms is kept free of shoots for the first four or five years very few will have to be removed later. In the above discussion it has been assumed that the Kniffen system of training is to be followed.

The mulching of young vines in the late fall with straw or strawy manure is recommended. The mulch not only serves as a protection but, when worked under in the spring, improves the physical condition of the soil.

THE TRELLIS

Posts and Bracing

Well-cured cedar posts are used by most growers. The end posts should be at least 5 inches in diameter and 8 feet long, the intermediate posts 3 inches in diameter and 8 feet long.

Steel posts may be used as intermediates and have several advantages over wooden posts, such as durability, ease of setting, greater freedom from frost heaving, and convenience in raising and lowering wires. When steel posts are used as intermediates every third or fourth post should be wooden. Unless this is done a strong wind when the vines are heavy with fruit may bend the entire row of steel posts.

The posts should be set approximately 30 feet apart in the row, depending on the planting distance of the vines, and, in the case of the intermediate posts, should extend into the ground 2½ to 3 feet. The below-ground part of wooden posts should first be treated with a wood preservative.

There are many methods of setting and supporting the end posts. (See Fig. 3.) In any case the end post must be set at least three feet in the ground to enable it to withstand heaving, and to support the weight of the vines and fruit. Perhaps the oldest method is that of bracing the end post with a rail or scantling from another post set about eight feet away in the row. The brace should reach from a point about a foot above the ground on the second post to within eighteen inches of the top of the end post. To complete the bracing a guy wire must be passed from about 6 inches below the top of the second post to a short distance from the ground on the end post.

This method requires considerable material and the brace sometimes pulls the end post out of the ground, but it is usually satisfactory.

A more satisfactory method, also shown in Figure 3, is to set the anchor post at a slight angle. The post is then guyed with a strong galvanized wire, one end of which is fastened to the post 1 foot from the top and the other to an anchor 3 feet from the post. A very satisfactory anchor is made by placing a 3-foot iron bar, with a slight bend at the bottom, and an inch eye at the top, in a post hole leaving the eye slightly above the surface of the ground. Approximately three gallons of concrete are poured around the bar as it is held in the centre of the hole. This makes a very permanent anchor and should last the life of the vineyard.

Wiring

The majority of the older vineyards have two wires, the plants being trained to the four-cane Kniffen system. Some growers prefer the six-cane system (requiring three wires) in that it spreads the growth over a larger area, thus making most cultural practices such as pruning, spraying, and harvesting somewhat easier. Then there is also the advantage that, in unfavorable seasons, more of the vine is spread out to the wind and sunshine, lessening disease and hastening ripening. In yield there is a slight difference in favour of three wires.

Use No. 9 galvanized for the top wire. A lighter wire gives way too soon. For the lower wires, especially on the short runs, a lighter weight may be used.

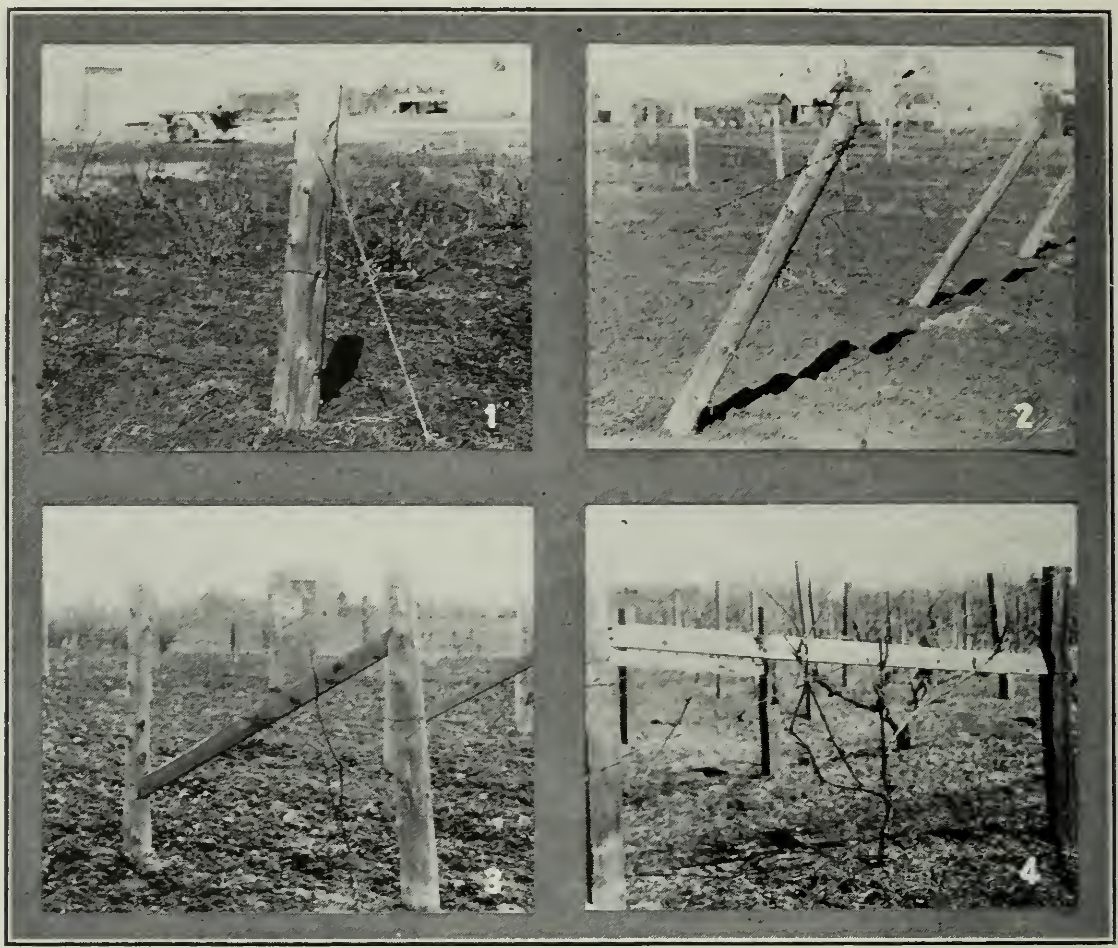


FIG. 3. Four methods of bracing the end posts. (1) Guy wire on straight end-post. (2) Guy wire on slanting end-post. (3) Short scantling brace. (4) Long scantling brace between end-post and special second post. Notice the guy wire in each case.

In a two-wire system the first wire is placed 30 inches above the ground, and the second 24 to 30 inches above the first. If three wires are used, the first wire should be at least 24 inches above the ground and the other two at 18-inch intervals above the first wire.

Wiring a vineyard may be done very quickly. Quarter-inch holes are bored in the end posts, the same direction as the wire is to be strung, and at the distances the wires are to be above the ground. When the wire is stretched along the row, the ends are passed through the holes in each end post and made fast to the wire tightener. While a proper wire-tightener with block and pulley is the most satisfactory, many simple devices may be used.

One of the most common is a block of hardwood, 1½ inches square and 8 or 9 inches long, with a quarter-inch hole bored through the middle of it. The wire is passed through the hole and made fast; then the wire is tightened by turning the block with a monkey wrench. The block is kept in place by its shape, together with the tautness of the wire.

Another method is to use a small iron reel on which to wind the wire after it passes through the hole in the end post. Probably the commonest of all iron wire-tighteners is the small, slightly curved iron bar about one-half inch in diameter. This can be wound up tight similar to the wood block.

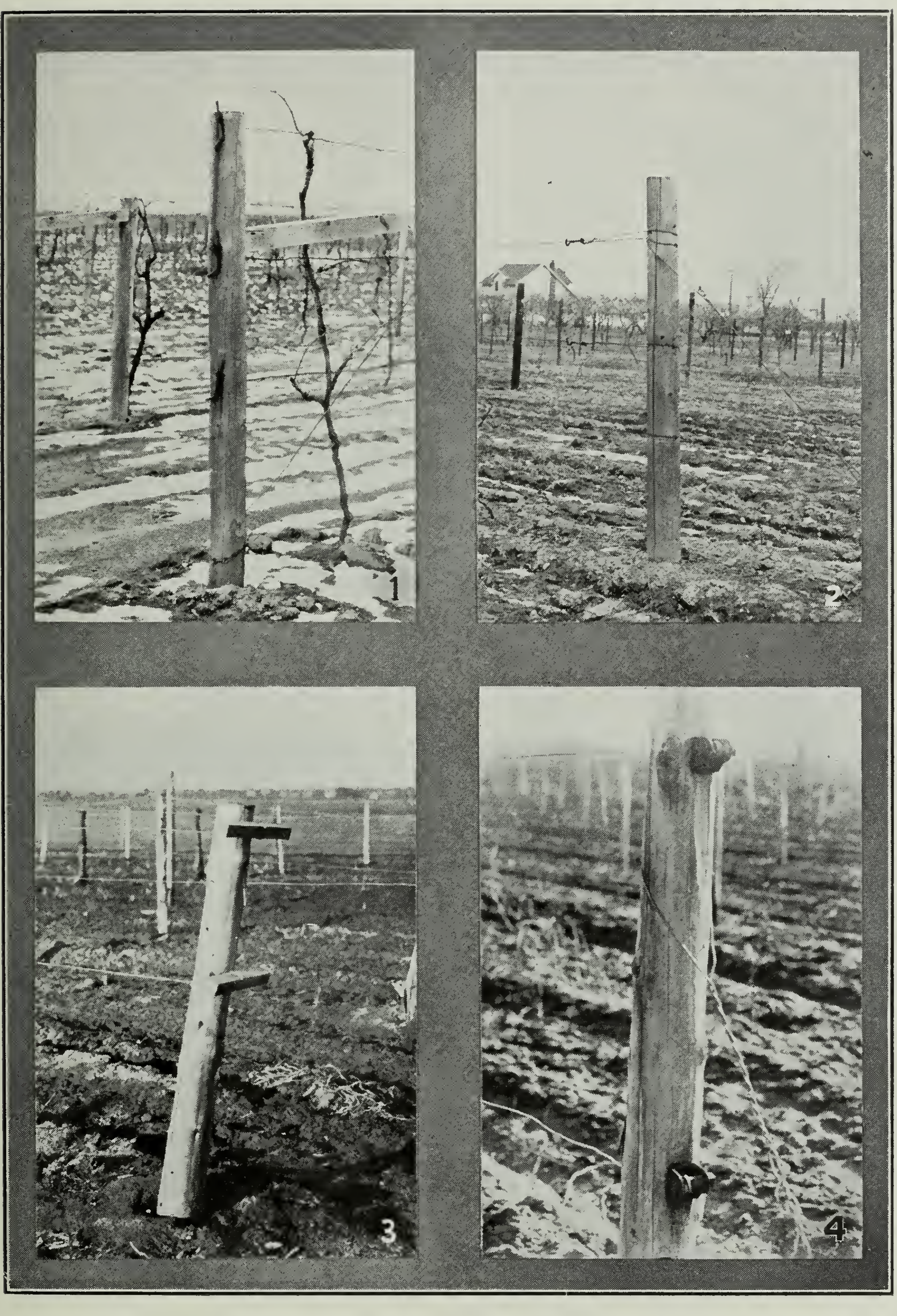
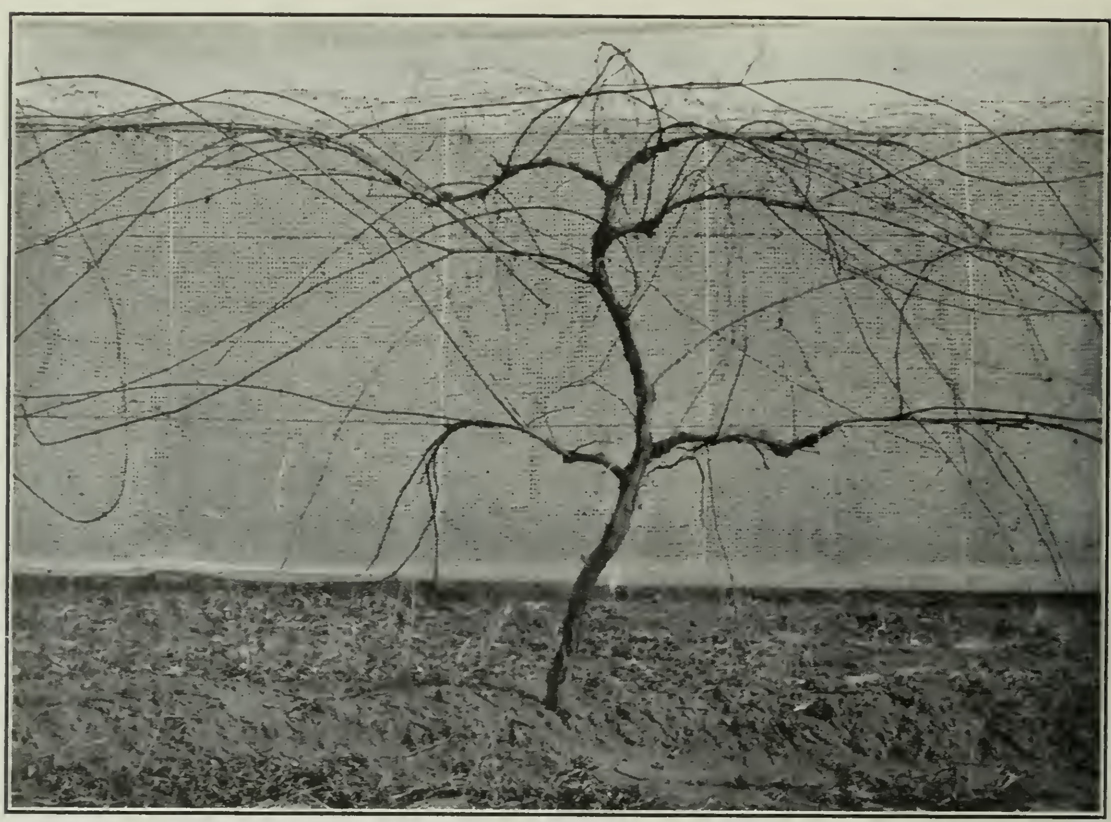


FIG. 4. Four methods of wire tightening. (1) ½-inch bent iron bar. (2) Large iron hook. (3) Square wooden block. (4) Iron reel. All four methods are good.



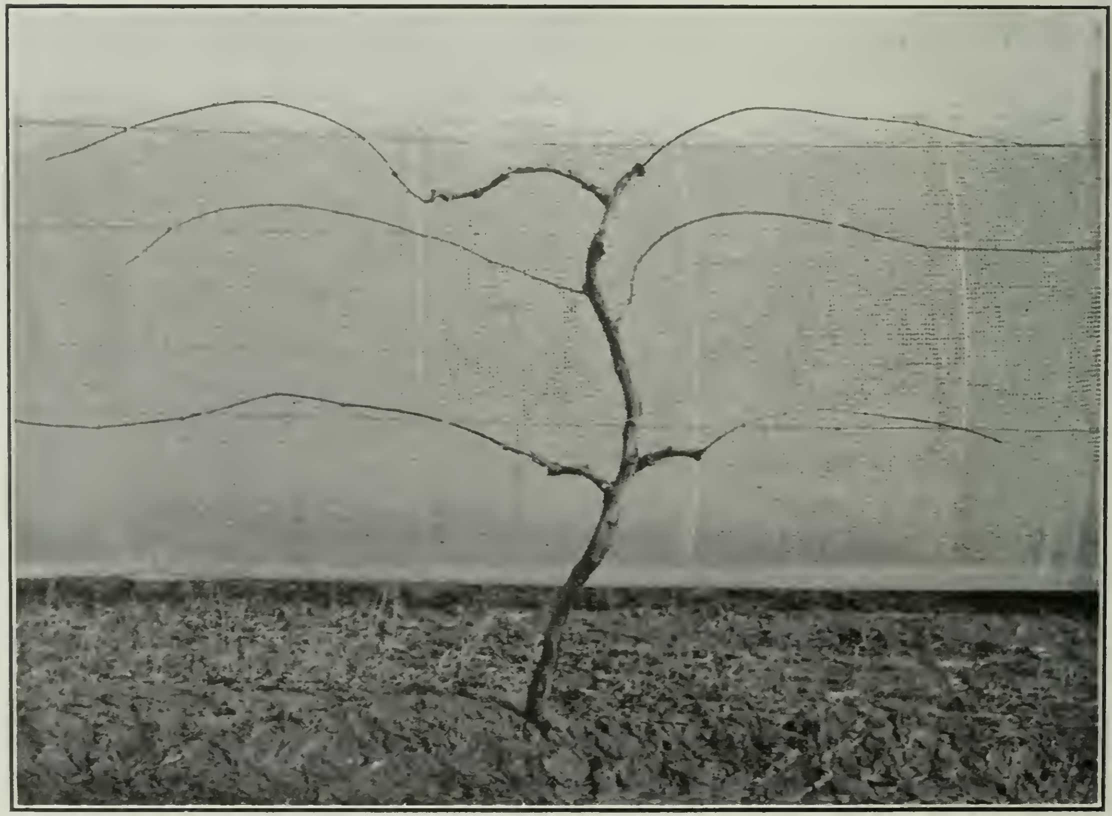
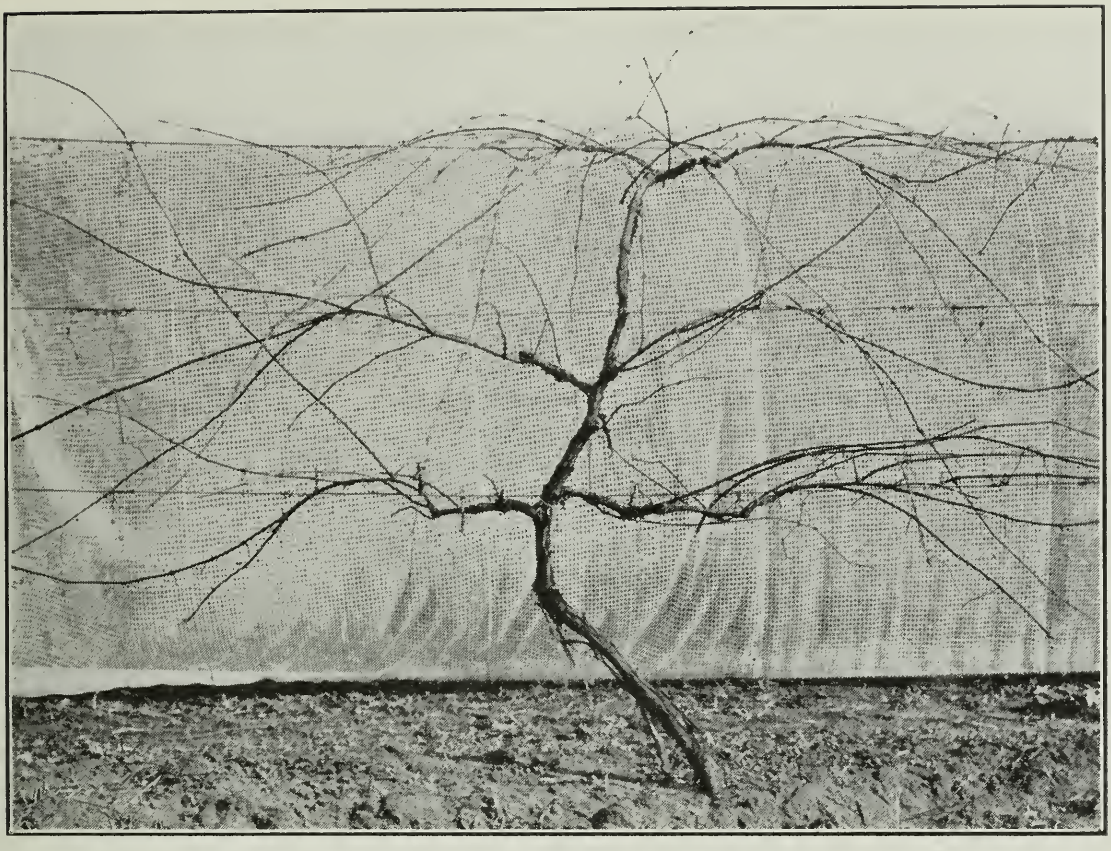


FIG. 5. Very vigorous Concord vine before and after pruning. Weight of wood removed was 4½ lb. Vine was pruned to 60 buds. Note that in Figs. 5, 6 and 7 the weaker the vine, the fewer buds are left.



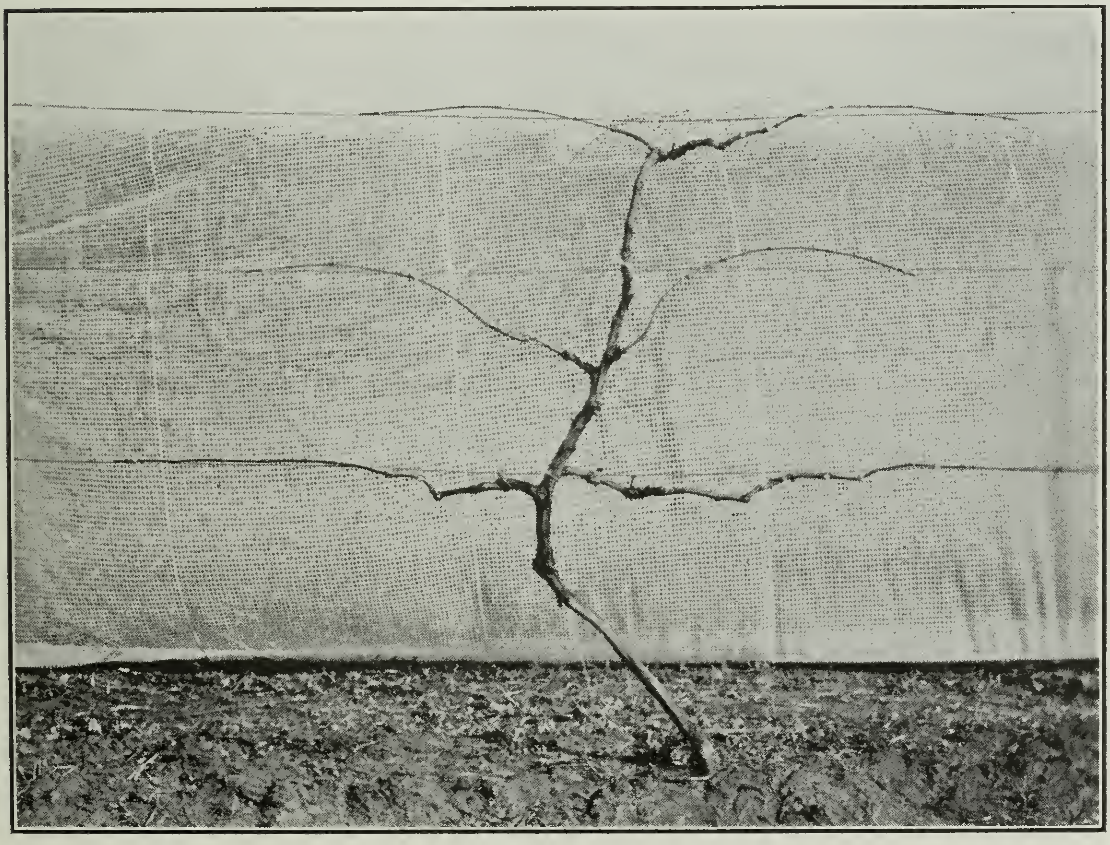


FIG. 6. Moderately vigorous Concord vine before and after pruning. Weight of wood removed was 2½ lb. Vine was pruned to 42 buds.

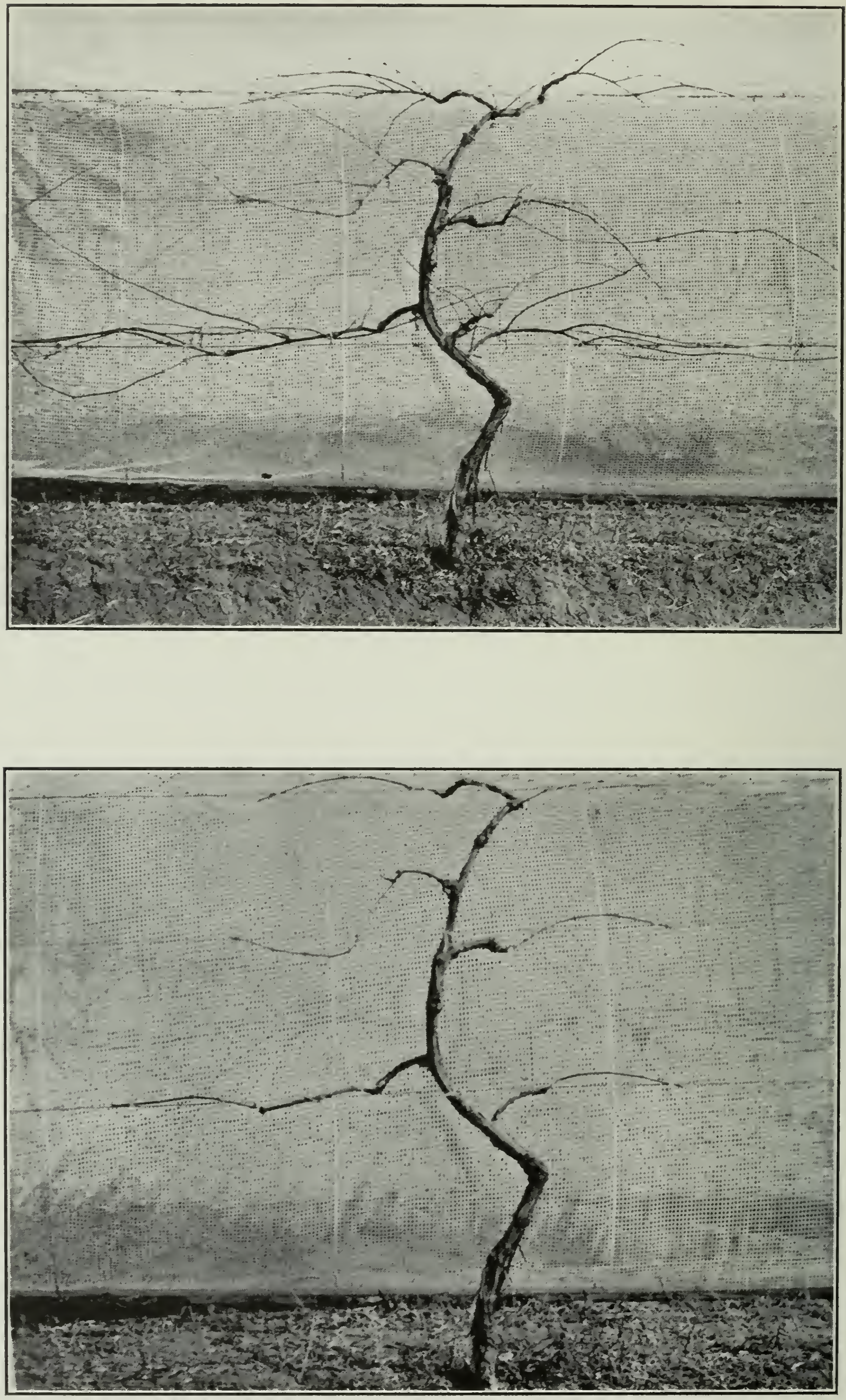


FIG. 7. Weak Concord vine before and after pruning. Weight of wood removed was 1 lb. Vine was pruned to 30 buds.

When stapling the wires to the wooden intermediate posts, space should be left to allow the free passage of the wire when it is slackened in the fall and tightened in the spring. Unless the wire is regularly slackened in the fall, it and the posts will be subjected to an undue strain when the already taut wire contracts with the cold weather. This strain will in time either loosen the posts or break the wire.

Number of Feet to the Pound of Different Sized Wire:

No. 9	Feet to the pound	17.95
10	Feet to the pound	22.33
11	Feet to the pound	27.34
12	Feet to the pound	34.29

PRUNING, TRAINING, TYING

Pruning

To the uninformed, grape pruning seems drastic. The bulk of the growth of the previous season is cut away, leaving only 4 to 6 new canes and these are reduced in length to 6 to 12 buds each. (See Fig. 5.) Fundamentally therefore, pruning is a simple operation but requires judgment in the selection of the few canes which are to remain. These should originate as close as possible to the trunk, or from it, and should be of normal vigour, about pencil size, avoiding weak growths and "bull" canes.

The pruning and training of young vines has been described in the section, "Care of the Young Vineyard." The present discussion concerns mature bearing vines.

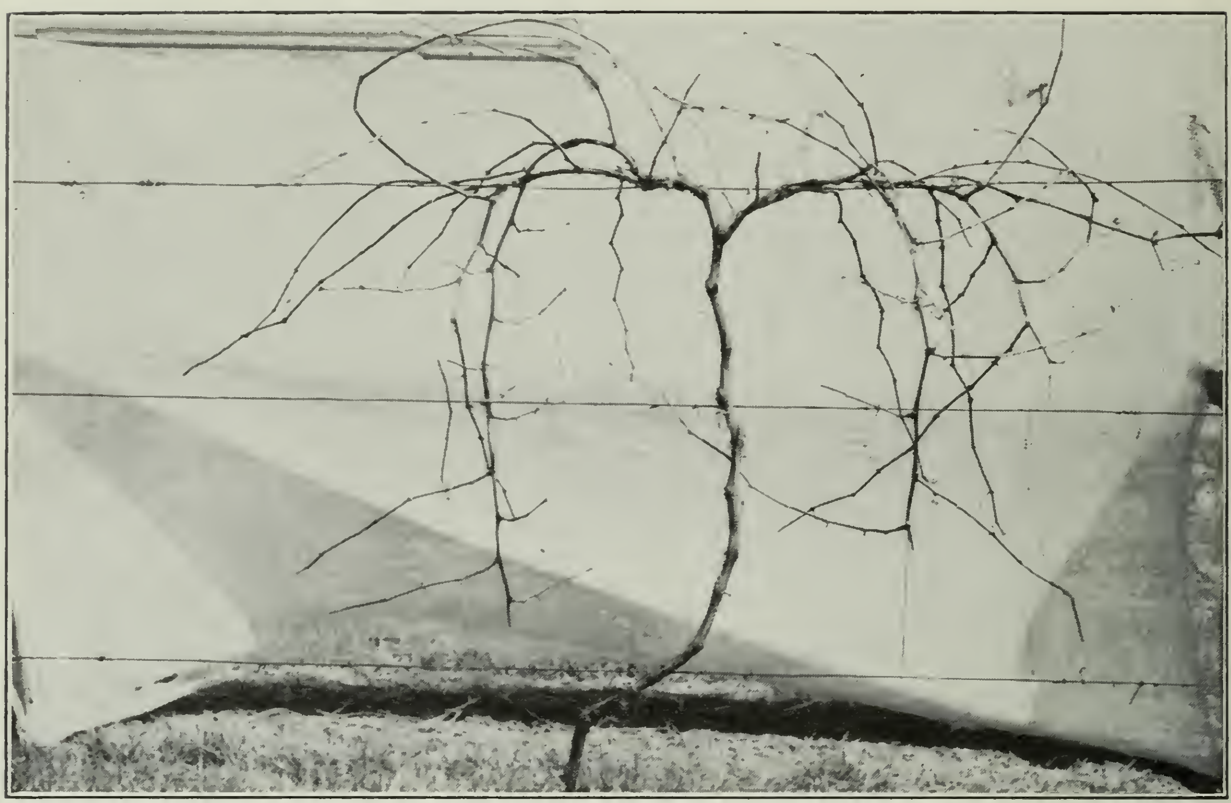
Systems of Training

In the Niagara district several systems of training are followed, such as the Fan, Horizontal Arm, four- and six-cane Kniffen, and "go as you please". The Kniffen and the Fan are most popular. In practice, the Fan system often becomes a Horizontal Arm. Many of the younger vineyards are trained to the six-cane Kniffen system, while the four-cane Kniffen is commoner in older plantings. The main advantage of following a particular system is that the work is simplified and standardized, particularly pruning and tying.

The Kniffen system is shown in the accompanying illustrations (Figs. 5, 6 and 7) and needs no further description. The relative merits of the four- and six-cane Kniffen systems are discussed under "Wiring".

In recent years the umbrella Kniffen system of training is regaining favour in New York State, and some Ontario growers are interested. It is a modification of the four-cane Kniffen system. For the first several years the training of young vines is similar to that described in the section, "Care of the Young Vineyard". When the vine is mature the umbrella Kniffen method consists of a single trunk headed 4 to 8 inches below the top wire, with from 1 to 6 canes arising from the head of the trunk. The canes, growing in opposite directions, are bent over the upper wire and extended to the lower wire at a sharp angle so the cane has a distinct bend at the top wire. (See Fig. 8.)

When the canes are bent over the top wire so the outer bark cracks the shoots arising back of the bend will be vigorous and will make good fruiting canes for the following year. Renewal spurs should be left at the head of the trunk.



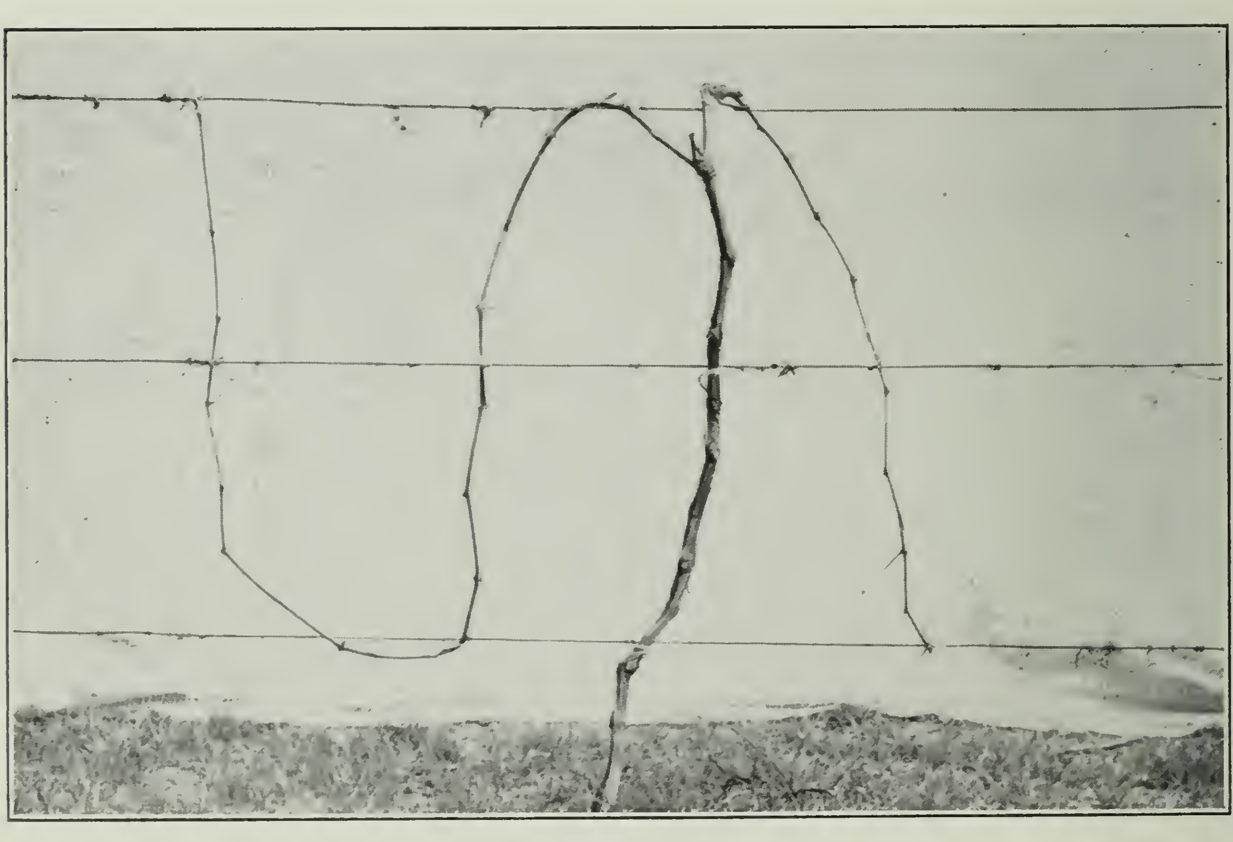


FIG. 8. An unpruned (top) and a pruned (bottom) vine, trained to the umbrella Kniffen system.

Time of Pruning

The usual practice is to do most of the pruning during January, February and March. However it may be done any time after the leaves have fallen, up until the vines start to "bleed" in the spring. The important point is that the vines be thoroughly dormant. Pruning should not be done on very cold days as the canes are then very brittle and those left may be injured in pulling out the brush.

Relation of Cane Diameter to Fruitfulness

That the bull canes are unproductive and undesirable is indicated in experimental data obtained by N. L. Partridge of Michigan. These data show that the medium or pencil-size canes of approximately one-quarter inch diameter are the most fruitful. An increase or decrease from this size is accompanied by decreased fruitfulness in both cases, the amount of the decrease being roughly proportional to the deviation from the optimum size. Where canes of the right diameter are unobtainable, those slightly above the quarter-inch are to be preferred to those falling below this diameter. In addition, canes of moderate length between the joints are to be preferred to short-jointed canes.

Number of Buds per Vine

The amount of wood or the number of buds to be left on the vine will vary with the variety and the vigour of the vine. Individual vines should be pruned according to their capacity to produce and ripen a crop, and this may vary from season to season depending on seasonal conditions, soil fertility, and amount of previous crop. Generally speaking, the greater the vigour, the greater the number of buds that may safely be left.

The date of maturity of the fruit is influenced by the size of the crop. This is an important point in the Niagara district, especially for those vineyards which are naturally inclined to be late in ripening. Vineyards close to the lake would fall in this class. In a general way, it may be stated that the greater the crop the later the maturity. It is obvious, therefore, that the grower who habitually suffers from too-late maturity should practise more severe pruning. In his case the optimum number of buds is determined by the date of maturity rather than the quantity of fruit that the vine can support year after year without noticeable impairment of vigour.

Delaware canes are short-jointed as are also many of the French Hybrids. (See Pruning the French Hybrids, page 18.) With Delaware, the number of buds should not be estimated by length of cane alone but by frequent count; otherwise far too many buds will be left by the average pruner.

The Rogers' hybrids, such as Agawam, are very vigorous growers and, apart from other considerations, a relatively large number of buds must be left or growth will be too rampant and of the bull-cane type. Also Lindley and Agawam normally mature early so that this factor does not need the same consideration. Herbert is later in season and does require consideration.

Other varieties need special attention. Fredonia, a very vigorous grower, should be pruned to a larger number of buds than Concord. Catawba, a weaker grower than Concord but a heavy producer, should be pruned to fewer buds.

It is evident then that no hard and fast rule can be laid down stating that so many buds, say forty, should be left for all varieties under all conditions. Rather, individual growers will have to determine the optimum number for their particular conditions, varying this number with the variety and to some extent with occasional vines which are above or below normal in vigour.

Partridge of Michigan has suggested that the weight of prunings should be used as a guide to the number of buds to be left per vine with the variety Concord (see Table 1). It may be useful for other varieties also as an indication of vigour, but specific data are lacking on the number of buds to leave with varieties other than Concord. This system has been used successfully in experimental work carried on in a vineyard near Jordan.

TABLE I. WEIGHT OF PRUNINGS AS A GUIDE TO THE NUMBER OF BUDS TO BE LEFT (CONCORD)

Pounds of Prunings	No. of Buds Left per Vine	Pounds of Prunings	No. of Buds Left per Vine
Less than ¼ lb.	16	2½	42
¼	20	2¾	44
½	24	3	48
¾	28	3¼	50
1	30	3½	52
1¼	32	3¾	54
1½	34	4	56
1¾	36	4¼	58
2	38	4½	60
2¼	40	For each additional ¼ lb. of prunings leave two more buds.	

Only the one- and two-year wood removed from the vine at pruning time is weighed. If older wood is removed it should not be weighed. It would be impractical to weigh all the prunings in a large vineyard; however, a pruner will soon learn to estimate the weight of prunings and to vary the number of buds accordingly. Prunings may be weighed occasionally to check on the work being done.

Pruning the French Hybrids

As stated previously the canes of the French Hybrids are short-jointed, similar to Delaware. Coupled with this they produce fruit close to the main trunk, the buds right next to the trunk being fruit-bearing buds. In Concord and similar varieties the first one or two buds are non-producers. Also the French Hybrids are very prolific. Because of these characteristics care must be taken at pruning time or too many buds will be left.

For the first two or three years vines should be pruned back to the main trunk, with two- or three-bud arms being left on the lower wire where the vines are strong. Bunch thinning, i.e. the removal of a percentage of the bunches just prior to blooming, may still be necessary to keep the vine from over loading. Vines which are permitted to overload are subject to winter injury, and, in some varieties, may kill outright. More buds can be left on vigorous varieties such as Seibel 10878, than on weaker-growing varieties like Seibel 7053.

Renewal Spurs

In addition to the four to six regular fruiting canes, it is often advisable to leave additional short two-bud spurs from which new vigorous canes close to the trunk may be secured the following season. The function of such spurs is of course to provide a renewal of fruiting wood close to the trunk, and it is therefore unnecessary to leave such spurs where the arms are already short.

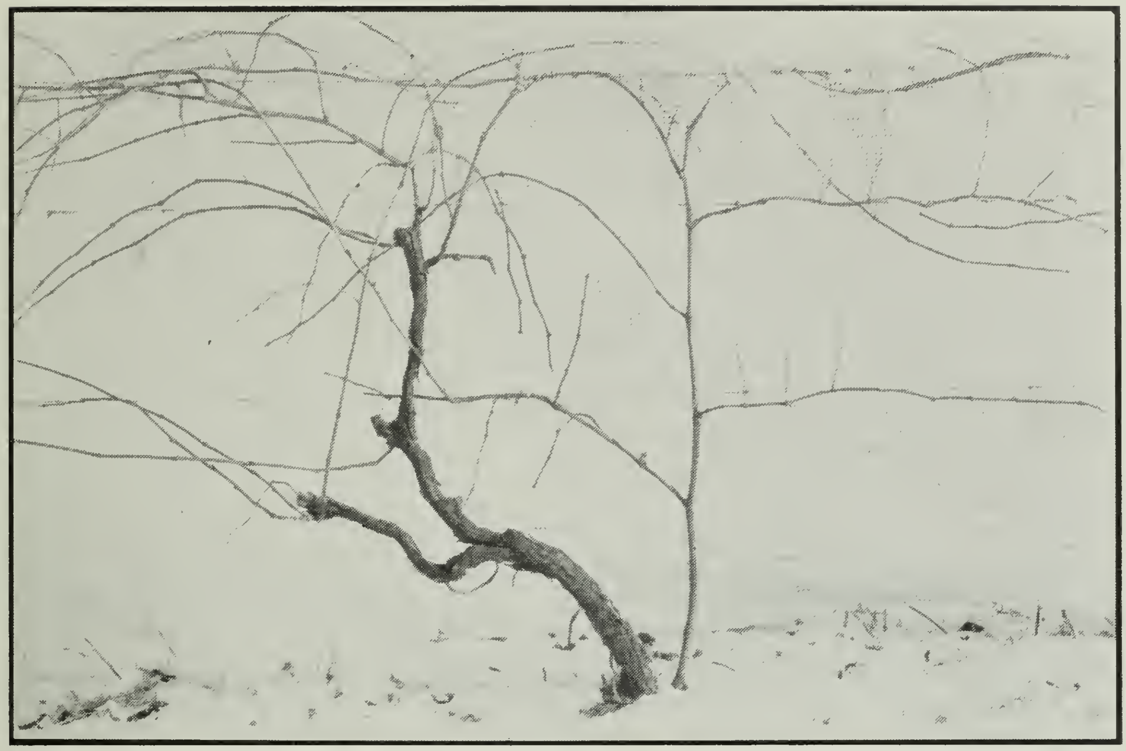


FIG. 9. Renewing a crooked old vine. The new vine is two years old. The old vine may now be cut away completely.

Renewing Old Vines

It is sometimes necessary to renew old vines where the trunk has become crooked and bent and has perhaps deteriorated from disease. If the root is healthy, such renewal can usually be effected by bringing a new shoot from near the ground. The old trunk may be removed at once, or may be left to fruit for one or two seasons until the new cane is ready to take its place.

The new shoot should be trained up to the top wire as rapidly as possible in the same manner as a newly planted vine. Any side shoots, except those needed for new arms, should be removed when not more than a few inches long.

Tying the Vine

Following the dormant pruning and the tightening of the trellis wires in the spring, tying is the next vineyard operation. Tying should not be done when the canes are frozen as they are then quite brittle and easily broken. Nor can tying be delayed until after growth starts because of the danger of rubbing off the new growth.

Both grape twine and fine wire are used for tying, though most growers prefer the twine, considering it to be better material. Wire should not be used to secure the trunk and main arms of the vine to the trellis because of the danger of girdling the vines.

The trunk should be tied to the wires in an upright, straight manner. Sagging, crooked trunks interfere with many vineyard operations. Before tying the canes (Kniffen system) it is a common practice to give the cane one or two twists around the wire. This secures the vine more firmly to the trellis than merely stretching the cane along the wire. However, such wrapped canes materially increase the difficulty of pruning the following season. In either case each cane should be tied twice, once at the tip, where a tight tie should be made, and once near the base; in this case a loose knot so that normal cane growth, without binding or girdling, may be made.

When tying with grape twine it is advisable to give the cord a couple of turns around the wire, knot it, and then tie the cane securely to the wire. This method prevents any slipping of the cord along the wire and, at the base of the cane, permits a secure though loose tie, thus allowing for cane expansion.

It is false economy to hurry over the tying of the vines or to use material for tying which is not sufficiently strong or durable. This always results in much troublesome retying and often in injured arms. (Two-ply grape twine is better than the single-ply.)

Suckering

Suckering is the removal of all the shoots which appear on the trunk of the vine at or below the surface of the soil. These suckers bear little or no fruit, and hence grow vigorously, appropriating food materials which should go to the vine. A great deal of time and expense will be saved if suckering is done carefully during the first four or five years of the vine's growth. After the fifth year very few suckers will be produced from vines which have been carefully suckered when young. Vines on which the work has been carelessly done will always produce an abundant growth of these underground shoots every year. Suckering should be done early in the summer before the shoots have become hard and woody. Old suckers are more difficult to remove than are the young shoots and, if imperfectly removed, the remaining part becomes an underground stub, a perennial source of trouble.

Summer Pruning or Topping

The removal of two or more feet from the end of growing shoots during the month of August is sometimes practised in the Niagara district. This is done to admit light to the fruit and to control mildew by permitting a better circulation of air through the vine. Topping has little or no influence on coloring of the fruit, contrary to general belief. Since this topping is done toward the latter part of the summer, a great number of leaves are removed, which is weakening to the vine. In the case of very vigorous vines this may not be serious, but if severe topping is practised annually it is bound to eventually weaken even the strongest vines and so reduce fruit quality. In the most severe topping, not less than seven to eight leaves should be left beyond the outermost bunch of grapes.

Topping is justified, if at all, only in seasons of excessive growth, and after mildew is seen to be developing. The grower might better avoid excessive growth and maintain reasonable vigour by varying the number of buds left at the regular dormant pruning, as outlined under "Number of Buds Per Vine".

Also, it should be remembered that reduction of leaf surface by summer pruning reduces the ability of the vine to manufacture food, and therefore reduces the sugar content — and quality — of the fruit.

VINEYARD SOIL MANAGEMENT

The general subject of soil management is discussed in some detail in Ontario Department of Agriculture Bulletin No. 457, to which the reader is referred. The following paragraphs deal briefly with soil management as it applies to vineyards.

Cultivation

The trend in all tree-fruit soil-management programs is towards a reduction in cultivation. Tree fruits such as apples, pears and sweet cherries are being grown successfully in sod. The cultivation for stone fruits, other than sweet cherries, is being greatly reduced. Although some cultivation is still believed necessary for best results in vineyards a reduction in the amount of cultivation will aid in maintaining soil structure, and ultimately benefit the vines. Cultivation should not be started in the spring until the soil is properly tillable, as working soil before it is in fit condition impairs its structure. However, since early growth in grapes is desirable, early cultivation is important.

The depth of cultivation is also important because the less the roots are disturbed the better for the vine. Some growers still practise plowing their vineyards. Fall plowing particularly is to be discouraged as leaving the ground bare over winter is now thought to be detrimental to the soil in other ways besides conducing to erosion. In most vineyards either the one-way or double disk will probably do a good job of cultivating with the least root disturbance.

To remove weed growth in the row many types of grape-hoes are used. Preference should be given to a grape-hoe that will give the least root injury. Experimental work in New York State has shown that in some seasons better vine growth and yield were obtained where no weed removal was carried out, compared to grape-hoeing with a tractor-mounted grape-hoe. The difference was apparently due to grape-hoe damage to the root systems. The highest yields were obtained where the weeds in the row were controlled with an oil-dintro emulsion.

New York growers have used this spray on a trial basis for three years with satisfactory results. It is suggested that growers keep in touch with developments in chemical weed-control as definite recommendations cannot be given until further tests are made. If the need of grape-hoeing can be eliminated by the use of chemicals for weed-control a great deal of root injury would be prevented.

All cultivation should cease by the middle of June or by the 1st of July at the very latest. The last cultivations should throw the soil up to the vines. This prevents water from settling about the vines during the winter, and gives soil to work down in the spring with less root disturbance.

Green-Manure Crop

Green-manure crops should be used in the vineyard wherever possible. Their functions are: to check growth in the fall, thus giving the vine time to mature its wood properly; to utilize nitrogen available in the soil after the vine has ceased growth, and prevent its loss by leaching; to hold snow and thus prevent deep freezing; and, of great importance, to maintain or improve the organic-matter content of the soil. A green-manure crop will help to prevent the topsoil washing away during heavy rains. If it is left standing over winter it will help prevent erosion, and will catch many of the grape leaves which add organic matter to the soil.

Organic matter may be said to form the basis of soil fertility. The grape is a long-lived plant, and unless organic matter is maintained the soil will eventually decline in fertility. Farm manure, of course, is one of the best sources of organic matter and should be used whenever it can be secured economically, as a supplement to green-manure crops.

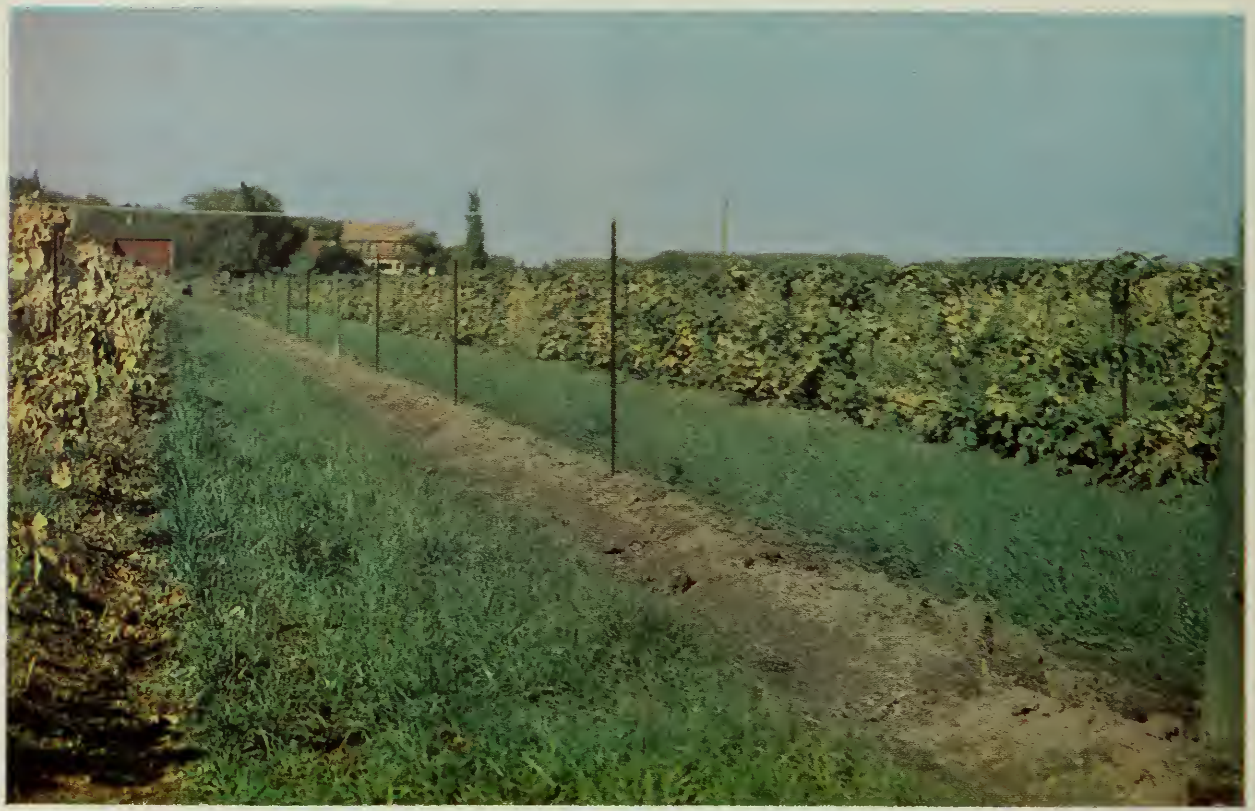


FIG. 10. Italian rye grass in mid-October. A good cover reduces erosion, and improves soil texture.

Some of the best green-manure crops are: Italian rye grass (15 lb. per acre), oats (1½ to 2 bu.), rye (1 to 2 bu.) millet (20 to 30 lb.). Oats and some millets (see Bulletin 457, Orchard Soil Management) make strong growth in the fall and may therefore be objectionable at harvest time. However, they may be knocked down with a stone boat or by running over them once or twice with a disk. On the other hand oats and millets are killed by frost, and there is no temptation to delay spring cultivation as in the case of rye which makes its heavy growth in the spring. It is essential that the first spring cultivation be done early. A delay gives a greater quantity of material to work under, but owing to its more mature condition it will break down too slowly, causing drying of the soil and reducing the soil's nitrate content, thus adversely affecting cane growth.

The green-manure crop should be sown as soon as cultivation ceases, or a crop of weeds may be allowed to grow. If the distance between the rows permits, it is preferable to use a grain drill to sow the green-manure crop, rather than a cyclone seeder, as no seed will then be sown under the vines. A green-manure crop there is difficult to turn under properly.

Fertilizers

In common with other fruits, grapes require a soil adequately supplied with organic matter. Farm manure and green-manure crops, as already indicated form the basis of the soil-fertility program. These, with proper soil drainage and adequate cultivation during the first part of the season, will probably furnish all the plant food necessary in most Niagara district vineyards.

In one of the Station fertilizer experiments the organic-matter and green-manure plots were the only ones returning an increase in crop yield sufficient to pay for the materials applied. This indicates the importance, especially where

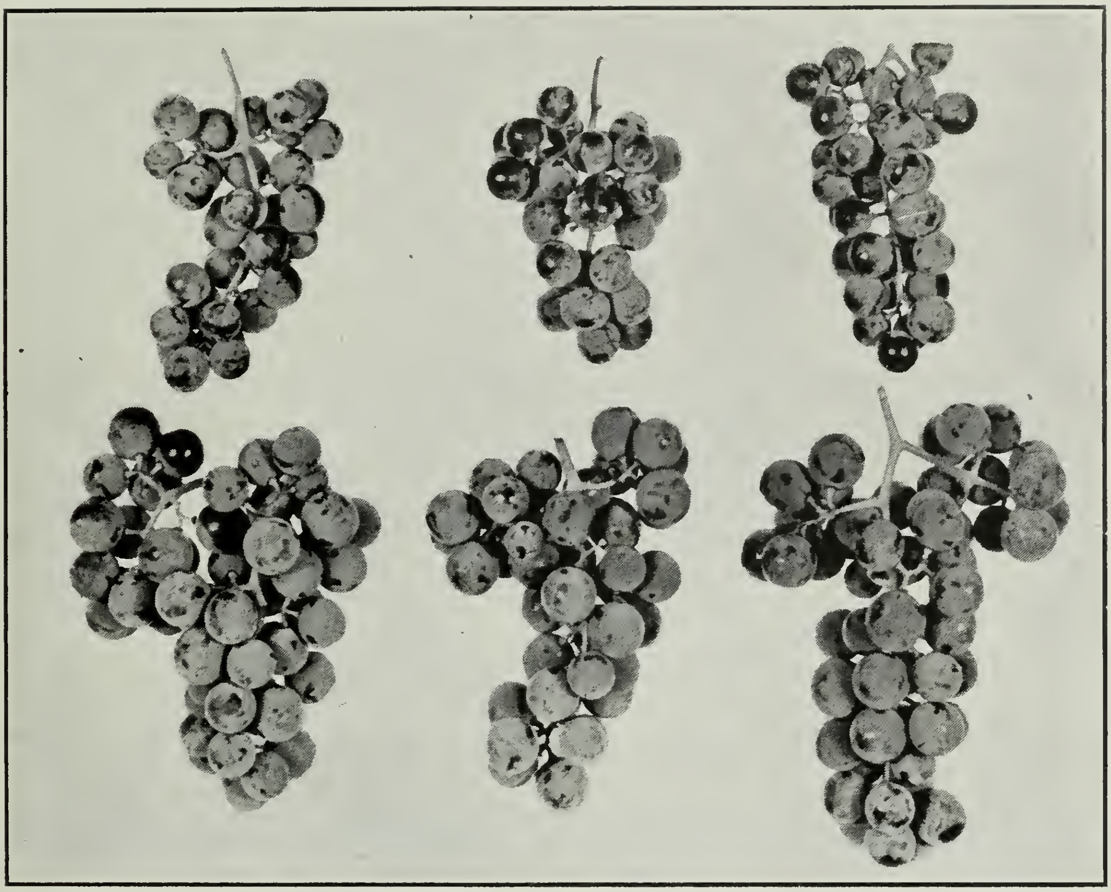


FIG. 11. Size of bunch is largely dependent upon the vigour of the vine. (Top row) Bunches of grapes from vines possessing poor vigour. (Bottom row) — from vines possessing good vigour. Both from the same vineyard.

manure is not readily obtainable, of encouraging the growth of green-manure crops by proper fertilization. The mineral fertilizers used to promote the growth of green-manure crops will eventually be returned to the soil in a highly desirable organic form which is believed to be more suited to horticultural crops than the inorganic form.

In this same experiment, the best response was from the NPK combination closely followed by the PK combination. It is quite possible that the effect was largely due to an increase in organic matter due to stimulation of weed growth by phosphate; at least, the increase in weed growth as a result of phosphate applications was quite obvious.

Soil tests showed that phosphate was low in this vineyard. In vineyards better supplied with phosphate, the response might not occur. In any case, fertilizers should not be applied blindly but only after a soil analysis has shown a need. In this better-than-average vineyard, nitrogen fertilizers were evidently not required but certainly there are vineyards which need nitrogen.

Since grapes have been shown to respond well to organic-matter additions, proper soil management should include the return of large amounts of organic matter to the soil, as manure, and as green-manure crops. By properly fertilizing the green-manure crop, growth will be stimulated and the grape will eventually benefit both from the added organic matter, and the nutrients obtained by the green-manure crop from the fertilizer. These nutrients are released when the crop breaks down, in a form that can be utilized by the grape. The following recommendations are based on the various considerations noted above.

1. Farm manure at the rate of ten tons per acre, applied at least every other year. The manure has some nutrient value but aids mainly in supplying organic matter.

2. When farm manure is not available and straw or hay are obtainable use as follows:—

(a) When using straw or non-legume hay, apply in the fall at least every other year at the rate of 3 tons per acre with 75 lb. of ammonium nitrate (or equivalent). Add another 75 lb. of ammonium nitrate (or equivalent) in the spring.

(b) Where legume hay is used, apply 2 tons per acre in the fall without nitrogen application. In this case there is enough nitrogen in the legume hay to satisfy bacterial decomposition.

3. Cease cultivation by June 15 and plant a suitable green-manure crop such as millets, oats, buckwheat, or preferably Italian rye grass. An application of 250 lb. per acre 2-12-10 or 0-12-20, made when seeding the green-manure crop, should be helpful in promoting its growth.

HARVESTING

The one point in connection with harvesting which really needs stressing is that of proper maturity. Practically all varieties of grapes reach full size and have good colour several days before they are satisfactorily edible. They are not mature in the sense of full development of sugar content, which determines quality. The result is that many varieties are harvested before they should be. This is true of the green varieties such as Niagara, as well as red and blue varieties. It is believed that the placing of immature, low quality grapes on the early market seriously interferes with the later marketing of better quality fruit.

It should also be noted and emphasized that there is no appreciable increase in sugar content once the fruit has been cut. Most kinds of fruits continue to "ripen" after picking, but not the grape. Ripening processes cease immediately the grape is cut. It is obvious, therefore, that grapes should not be cut, even if well coloured, until sugar development is sufficient to ensure good quality. Taste is an easily made maturity test, if honestly interpreted. However, the refractometer, now coming into general use, gives a quick, definite sugar test which can be directly related to a satisfactory picking maturity for a given variety.

A four-year experiment, carried out at Vineland from 1931 to 1934 with the varieties Niagara and Concord, showed the following losses in fruit weight caused by cutting before the crop was mature. By cutting two weeks ahead of proper maturity 11.4 per cent less crop was harvested of Niagara and 9.6 per cent less crop for Concord. In other words, had the grower waited until the fruit was mature, for every ton of grapes he cut two weeks early he might have cut 2,228 lb. of Niagara and 2,192 lb. of Concord. Translated into six-quart baskets, this increase would amount to 25 baskets of Niagara and 21 baskets of Concord per acre.

SELECTION OF VARIETIES

In discussing varieties the ultimate use of the fruit, whether for wine, table, grape juice, or preserving, should be considered. It is estimated that, over the years, sixty-eight per cent of the grape crop has been used by the recognized commercial winneries in Ontario, while a further ten per cent, possibly more, has been eventually made into wine. The grower, therefore,

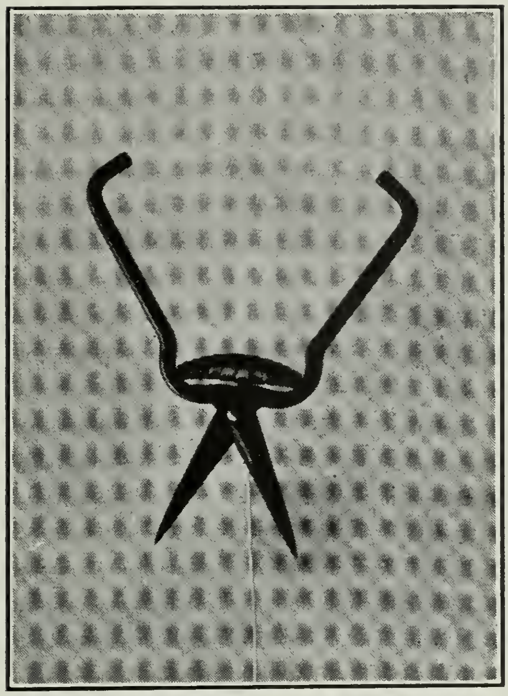


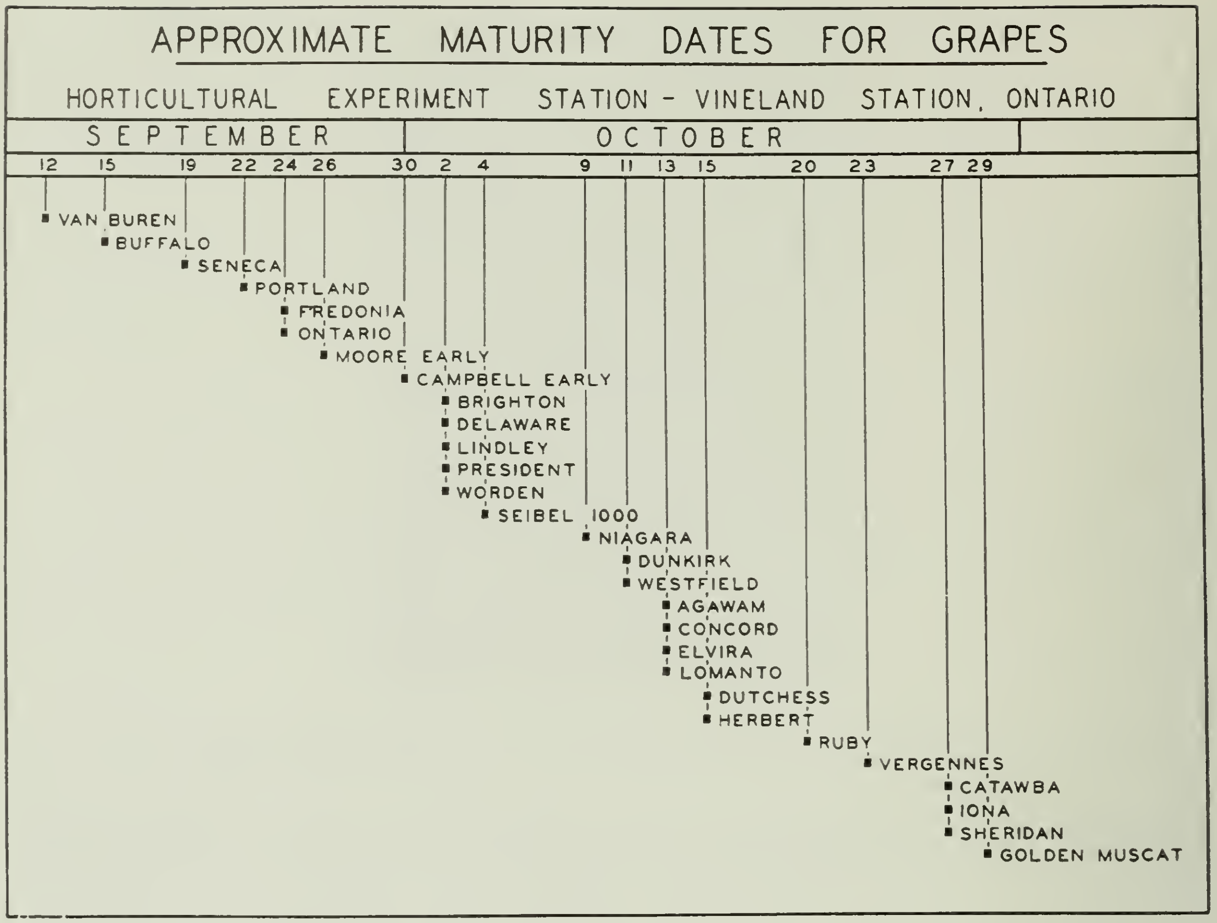
FIG. 12. The best type of clipper to use in cutting the crop.

cannot disregard the fact that the bulk of our grape crop is used for wine and that other outlets, while important, nevertheless constitute a relatively smaller market.

The history of grape growing in the Niagara district shows that grapes originally were grown primarily for table use, and that wine production came later. Most of our varieties, therefore, still have a dual purpose which is an advantage to the grower in the event that one or the other outlet fails temporarily. However, Concord, the principal dual-purpose variety, does not make wine with as high quality as can be made from some other varieties which, however, have little or no value for table use.

In recent years wine makers interested in producing higher quality native wines have been re-testing the older American wine varieties such as Catawba, Delaware, Dutchess, Elvira, and are testing newer sorts including Lomanto, President, the French Hybrids, and unnamed seedlings. Unfortunately good wine-making qualities are not always accompanied by desirable vine characteristics such as productiveness, hardiness, adaptability to varying soils, ease of propagation, all of which are of paramount importance from the grower's standpoint. Delaware is an excellent variety for making wine, but is not popular with the grower because of high production costs due to lack of vigour in the vine and low per-acre yield. Catawba ripens too late to succeed generally in the Niagara district, though it was once successfully grown on Pelee Island. It may nevertheless be a useful wine grape even though low in sugar content.

Summarizing then, the grower, in selecting suitable varieties to plant, should consider the various factors noted previously, and particularly must have regard for the newer varieties of possible value for wine purposes. The varieties listed are those that are being grown either for wine or for dessert purposes at the present time. They are listed in order of maturity. In the variety descriptive notes the particular purpose for which each variety is best adapted is given.



General Planting – Fredonia, Ontario, Delaware, Niagara, Agawam, Concord.

Limited Planting – Van Buren, Seneca, Buffalo, Elvira, Lomanto, Herbert, Catawba, †French Hybrids.

**Special Purpose* – Seneca, Portland, Fredonia, Ontario, Erie, Delaware.

†See page 31.

*Kingston East.

VARIETY DESCRIPTIVE NOTES

General List

The accompanying brief notes are not intended to be completely descriptive. The purpose is rather to indicate the value of each variety based on its performance at Vineland or with Ontario growers who also have it under observation. Generally, therefore, it may be assumed that, unless otherwise indicated, a given variety is commercially satisfactory in such characteristics as hardiness, vigour, cropping ability, fruit size and appearance, quality, etc. It has seemed of more importance to indicate special qualities or limitations, or some particular distinction of value to the grower in determining whether or not to plant.

Also it should be recognized that the variety comment or appraisal applies to commercial grape districts in Ontario. Performance elsewhere may well be substantially different.

Agawam (Rogers' 15). A self-fruitful Rogers' hybrid; vigorous, usually hardy, moderately productive, subject to mildew. The fruit is red, large and attractive, foxy in flavour and with a thick skin and coarse pulp. The fruit stores well. Makes a medium quality wine.

Brighton. A self-unfruitful, red variety, suitable only for local and roadside marketing because of the thin, easily broken skin and poor keeping quality. The vine is vigorous, productive, adapted to various soils. The bunches are moderately large, attractive, and the quality of the fruit excellent.

Buffalo. An early blue grape. Not quite so early as listed in the maturity-date chart (page 26), but matures with Fredonia. Vine is moderate in vigour and has shown signs of everbearing when young. May require heavier pruning than Concord. When well grown, Buffalo is of high dessert quality, and also has shown some promise for wine.

Campbell (Campbell's Early). Satisfactory only on light, deep soils, where the vine is hardy, vigorous and productive. On such suitable soils the bunches and berries are large, attractive, and blue-black in colour. On heavy or "normal" grape soils Campbell ripens unevenly and the bunches are poorly filled and straggly. The quality is excellent when mature. It is often cut immature because it colours early, and the quality is then poor and acid.

Catawba. A red variety, used for wine, which requires too long a season to be generally grown in the Niagara district. It has succeeded quite well on Pelee Island, the most southerly part of Ontario. In the Niagara district it ripens better back from the lake shore and on warm, well-drained soils. The foliage is subject to mildew in some seasons. There appears to be a steady though limited demand from wineries for Catawba, even in seasons when it does not mature well and is low in sugar.

Concord. Adaptability to varying soils and climatic conditions have made it the most popular variety in Ontario for juice, wine, and dessert purposes. The vines are vigorous and productive. The blue fruit does not have high quality, is foxy, but is nevertheless a popular table grape. It tends to shell badly if held some time after picking. Although Concord has been the main wine grape, there is an increasing effort to improve the quality of wines, using potentially better wine varieties. Present plantings of Concord will probably more than take care of the demand for juice and dessert purposes and for its continued use as a wine variety.

Delaware. The best of our varieties with respect to quality and, because of this, commanding a premium as a table grape on most markets. It is also widely used for wine. The bunches and berries are small and the vines lack vigour so that close planting is necessary to bring up the per-acre yield. The foliage is quite susceptible to mildew. Delaware requires a deep, rich, well-drained soil, thorough cultivation, and relatively heavy pruning. Yield has been improved by using grafted plants on a four-wire trellis. In the nursery row, vines are susceptible to winter freezing. Permanent planting is best done in the spring.

Dunkirk. Originated by the N.Y. Agr. Exp. Station and introduced as a red variety to fill the place of Delaware. The variety is described as having vigorous, hardy, healthy, productive vines, with medium-size clusters of fruit of good to very good quality, ripening shortly before or with Concord. The skin is tough enough for shipment. At Vineland, Dunkirk has given an indifferent performance.

Dutchess. A green grape which has been used for champagne. The vines are somewhat tender to cold and capricious as to soil. Foliage and fruit are susceptible to mildew. When well grown the bunches are medium size and well filled, and the fruit of very good quality. Not adapted to heavy clay soils. It makes a high quality wine.

Elvira. An old white variety useful mainly for wine. Vigorous, hardy, very productive, probably out-yielding Concord. Fruit cracks easily. Elvira is being planted to some extent for wine purposes.

Fredonia. A vigorous, hardy, productive black grape. One of the best early varieties. In pruning, more buds should be left than with Concord because of Fredonia's more vigorous growth. Foliage and fruit susceptible to mildew. Berries and bunches moderately large, good quality.

French Hybrids. See page 31.

Golden Muscat. A yellow-green variety which ripens too late for most locations in the Niagara district. The vines are vigorous, hardy, productive. The bunches and berries are very large and impressive in appearance. In a long warm season the fruit attains fair to good quality, though the flesh is somewhat stringy. The tender skin would limit it to roadside or local markets.

Herbert (Rogers' 44). A self-unfruitful "Black Rogers," very vigorous, hardy; fruit handsome, large, of very good quality; keeps well in storage. As with all self-unfruitful varieties it must be interplanted with another variety producing good pollen. Even when this is done the bunches are frequently somewhat loose and the crop therefore not heavy.

Iona. An old red variety of good quality, rivalling Delaware as a dessert grape. Also it makes a good wine. Unfortunately it is capricious as to soils and requires exceptional care in growing, otherwise vineyard performance is indifferent to poor.

Ives. Some years ago Ives was planted in fairly large quantity in the Niagara district on the strength of its reputation for making red wine. Under our conditions the vines proved weak and unproductive so that the variety has again fallen into obscurity.

Lindley (Rogers' 9). A self-unfruitful red Rogers, requires interplanting to ensure a crop. Vine very vigorous, fairly hardy, somewhat susceptible to mildew. The variety is on the way out and is now chiefly found in old vineyards. Not sufficiently productive for commercial planting. Dessert quality very good.

Lomanto. A black grape suitable only for wine purposes, where the very deep-colored juice is of value for blending. Vines are vigorous, hardy, productive, equalling Concord in yield and in vineyard performance generally.

Moore (Moore's Early). Now being replaced by Fredonia. Moore prefers a rich, loose, well-drained soil. The berries sometimes crack and shell badly and bunches may be loose. Vines of medium vigour, hardy and moderately productive. Dessert quality fair to good.

Niagara. The most widely planted green grape, but losing in favour for both wine and dessert purposes. Vigorous, only moderately hardy. When well grown, Niagara is more productive than Concord, but more susceptible to disease. Quality good when properly mature. Foxy.

Ontario. Vines vigorous, productive, moderately hardy, prefers the heavier grape soils. Bunches are a little loose and the fruit, which is green, does not keep or ship too well. Good for dessert but not liked by the wineries. First class for home use. Ontario ripens about with Fredonia.

Patricia. Ripens with or just after Moore. Vines vigorous, productive, healthy. Quality only fair, flesh somewhat pulpy. Its chief value lies in its earliness combined with vigour and productiveness as compared with Moore. Fredonia is a better all-round blue variety than either Patricia or Moore.

Portland. An amber-colored variety ripening about with Ontario or a few days earlier than Moore. The vines are moderately vigorous, hardy, moderately productive. The quality of the fruit is not as good as Ontario, being somewhat foxy. It is better suited to sandy soils than Ontario, and like Ontario the bunches are somewhat loose. The fruit does not keep or ship too well.

President. A black-fruited variety with medium-size bunches, medium to large berries. Vines moderately vigorous and hardy, difficult to propagate. Used for production of high quality wine.

Ruby. A new red variety not generally known or planted in Ontario. Vines are vigorous, hardy, productive. Ruby follows Concord in season. Colours poorly in adverse seasons. Some interest for wine being shown in this variety.

Seibel Hybrids. See **French Hybrids**, page 31.

Seneca. A very early white or yellow grape having fruit qualities of the European type. Bunches are medium size; flesh firm, tender, excellent quality for dessert. Attractive to birds and therefore must be watched closely as it approaches maturity. Vines vigorous, hardy, productive. Nursery vines susceptible to winter injury. Probably best transplanted to the vineyard in the spring.

Sheridan. A black grape which ripens too late for most locations in the Niagara district, otherwise it would be useful to extend the Concord season. The vines are vigorous, hardy and very productive. Where it ripens the quality is better than Concord.

Van Buren. Promising as a very early black variety for roadside markets. Clusters medium size, berries smaller than Concord; quality similar to Concord. Vines moderately vigorous, hardy, moderately productive.

Vergennes. A late red variety which benefits from being interplanted with other varieties. The vines have a straggly habit of growth which is objectionable, and are variable in vigour and hardiness with a tendency to overbear. In warm seasons and when the crop is moderate it ripens well, is attractive in appearance, and stores well. In cool seasons, or where the crop is excessive, it ripens unevenly and colours poorly.

Westfield. A blue variety maturing just ahead of Concord. Clusters are medium size, compact, berries shatter if left on the vine too long. Has shown some promise for juice and wine. Vine moderately vigorous only.

Worden. An old blue variety. Compared with Concord, bunches and berries are larger; it is 7 to 10 days earlier, not as heavy a bearer, quality better, not as adaptable to varying soils. Crop is improved when it is pollinated by another variety. Berries are apt to split in wet weather. Does not hang on the vines or ship well.

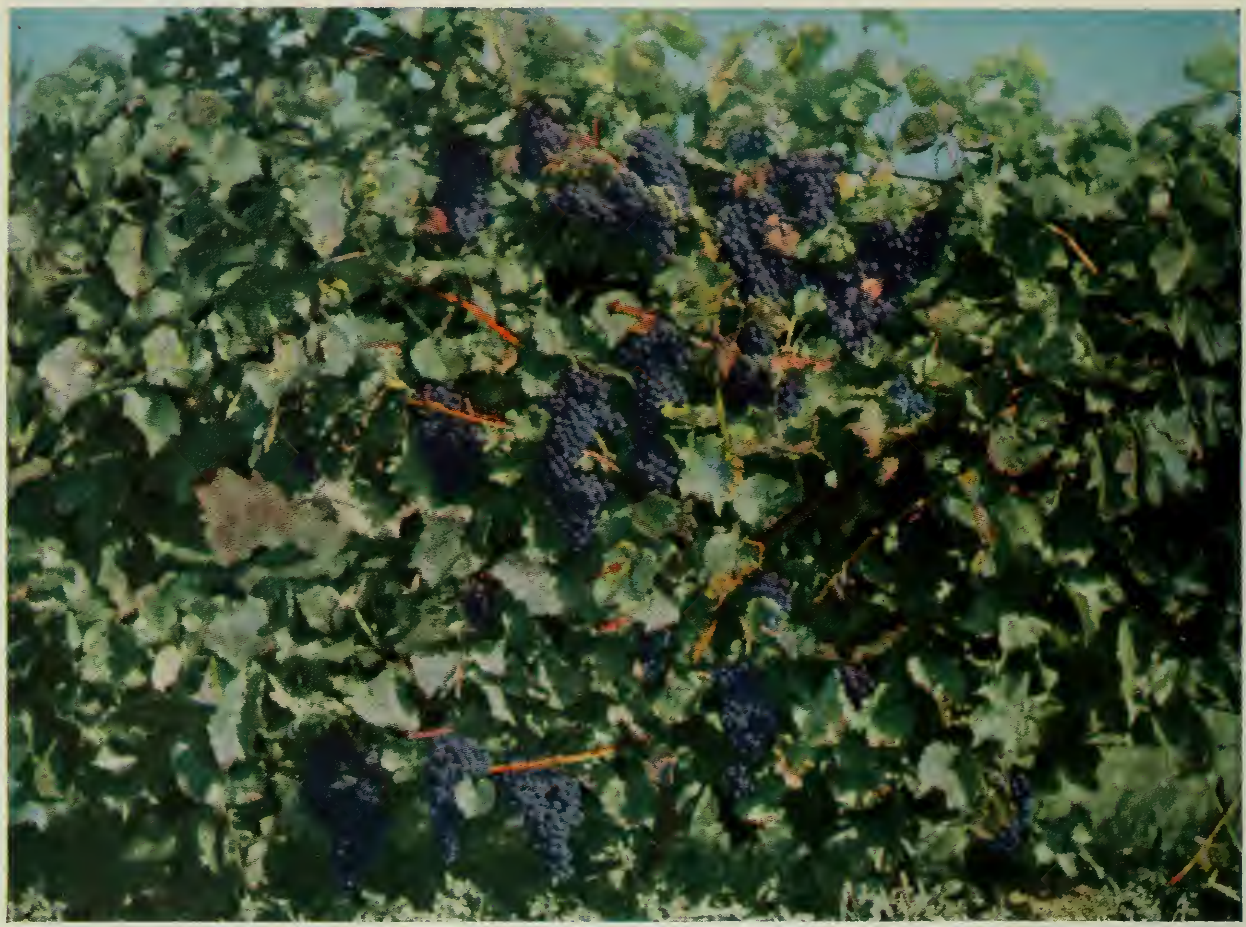


FIG. 13. Seibel 7053. A French Hybrid grape.

GRAPE SURVEY

TABLE II. NIAGARA DISTRICT* GRAPE ACREAGE WITH NEW PLANTINGS, 1942 TO 1947

Variety	Full bearing	1942	1943	1944	1945	1946	1947 (proposed)	Totals
	acres	acres	acres	acres	acres	acres	acres	acres
Concord	8,729	61	133	225	216	409	483	10,256
Niagara	1,906	4	66	28	30	70	74	2,178
Fredonia	229	7	29	39	46	165	65	580
Agawam	401	—	7	3	9	20	34	474
Delaware	62	—	—	8	8	42	47	167
Elvira	31	—	—	—	29	51	24	135
Catawba	39	—	4	5	5	21	44	118
Moores	49	—	—	—	—	1	5	55
Ontario	23	—	—	5	2	9	3	42
Worden	32	—	—	3	3	—	—	38
Campbell	21	—	—	2	1	4	3	31
Patricia	28	—	—	—	—	—	—	28
Champion	18	—	—	—	—	—	—	18
Portland	15	—	—	—	2	—	—	17
Rogers	14	—	—	—	—	—	—	14
Lindley	13	—	—	—	—	—	—	13
Misc.†	86	3	—	25	48	49	61	271
	11,696	75	239	343	399	841	843	14,435

* Townships of:—Binbrook, Clinton, Grantham,, Louth, Niagara, N. Grimsby, Saltfleet, Stamford, Pelham and Thorold.

A 1947 survey undertaken co-operatively by the United Grape Growers' Assn., the Ontario Wine Producers Assn., and the Ontario Department of Agriculture.

† Includes Brighton, Caco, President, Seibel 1000, Seneca, Vergennes.

European Types

The many European or vinifera type varieties which have been tested at the Station have not proved to be commercially satisfactory for our conditions. Most of the varieties require a longer and warmer summer than we have and many varieties are not winter-hardy. The experience of the U.S. Department of Agriculture, quoted below, has been the same with the varieties which they have tried in the Eastern United States.

"The growing of vinifera grapes in the Eastern States should be considered purely as an experiment. All of these varieties are very susceptible to fungous diseases and require careful and repeated spraying to protect the fruit and foliage from disease . . . None of the varieties has been sufficiently productive to indicate the probable economic success of commercial vinifera production in the East. Results have shown that if sufficient care is taken, the amateur gardener who is willing to spend time and money in production of grapes of this type may have fair success under climatic conditions similar to those prevailing in the vicinity of Washington." (From U.S.D.A. Circular, Vinifera Grapes in the East, by J. R. Magness.)

In Ontario, interested growers and home gardeners should restrict their trials to the earlier-maturing varieties and must also accept the idea of much greater cultural care if good crops of satisfactory fruit are to be obtained. In commercial production this means specialized knowledge of the cultural requirements, considerably increased production costs over Concord and similar varieties, and correspondingly increased selling prices.

French Hybrids

In recent years there has been an increasing interest in the French Hybrid grapes particularly for wine purposes. This hybrid group originated in France by crossing European varieties (*Vitis vinifera*) with certain of the wild American species. The French stayed away from *Vitis labrusca*, the *'fox'* grape (Concord etc.) and used mainly *V. rupestris* and *V. lincecumii* in their crosses. Several French breeders, Seibel, Ravat, Seyve-Villard, Bertille-Seyve and others have been carrying on this work for three-quarters of a century with the object of securing varieties bearing fruit similar to the European varieties but possessing the hardy, disease-resistant vine characteristics of the wild American species.

There is now a long list of these French hybrids introduced by several breeders and possessing many different characteristics. In 1946 the Horticultural Experiment Station obtained direct from France thirty-five of the earlier maturing hybrids which, by their descriptions seemed to warrant trial under Niagara conditions. They were planted out in the fall of 1947 and spring of 1948. One row of each variety (150 vines) was planted, part of each row being on a sandy knoll and part on a stiff clay. The vines on the sandy knoll made very vigorous growth in their first two years and bore a heavy crop in 1950. The summers of 1948 and 1949, being quite dry, the vines on the clay have not as yet made growth equal to the vines on the sand knoll. They are improving as they become better established.

From the limited time these grapes have been under test only preliminary evaluations can be made. The following varieties have shown some promise:

Seibel 1000. This is one of the first French hybrids to be grown. There are already a few commercial plantings in the Niagara district. Medium to small bunches of oval, blue berries. Vines vigorous and moderately productive.

Inclined to produce green berries in the bunches. Attractive to birds. Distinct wine possibilities.

Seibel 5437. A blue grape with highly colored juice. May be useful for blending. Bears a heavy crop of large to very large bunches. Season week before Concord.

Seibel 5455. Vine has been vigorous and productive although noted as lacking in hardiness in some sections of the United States. At Vineland, it had a nicely distributed crop of fine-looking bunches in 1950 and 1951. It is a blue grape ripening a week before Concord.

Seibel 7053. This is one of the standard blue varieties grown in France. At Vineland it is a vigorous grower and produces very heavy crops of large-size bunches. In 1950 and 1951 considerable mildew early in the season caused some straggly bunches. There is considerable interest in this variety as a wine grape. Concord season or just before.

Seibel 8229. Vines vigorous and productive, growing better than any of the other Seibels on heavy clay. A yellow grape which may be very good if wine qualities prove satisfactory. Week before Concord in season.

Seibel 8357. This blue variety has borne two very good crops of large fine bunches which ripened evenly despite a heavy crop. It has high acidity, very high juice colour and, in early tests, has been promising for wine purposes. Concord season.

Seibel 9110. This yellow variety has been promising for both wine and dessert. Vine is medium in vigour. clusters are above medium in size and are rather loose. Berries are medium in size, ovate, crisp, and excellent in quality. Week after Fredonia in season.

Seibel 10868. A yellow variety that has shown wine possibilities. The vine is medium only in vigour. Considerable winter injury where vines loaded heavily in 1950. Clusters are medium to large in size with medium-size berries. Concord season.

Seibel 10878. Vines are very vigorous and productive. A blue grape that has shown considerable promise for wine. Bunches are medium to large in size and have varied in compactness. Well worthy of a limited trial. Week before Concord in season.

Seibel 14664. Vines of medium vigour only. Bunches and berries are very large. Fruit oval "vinifera" type. The flesh is solid and the skin edible, making it a good dessert grape. White.

INSECTS AND DISEASES

The following very brief discussion is intended merely to assist the grower in recognizing the various symptoms and injuries caused by the common diseases and insects attacking grapes. Mention is made of cultural practices that assist in controlling the diseases and insects, but since spray recommendations are frequently modified, no directions for spraying are given, and the grower is referred to the Ontario Spray Calendar.

Where the spray schedule does not provide for the insect or disease, the grower is requested to write to the Horticultural Experiment Station for the latest control measures.

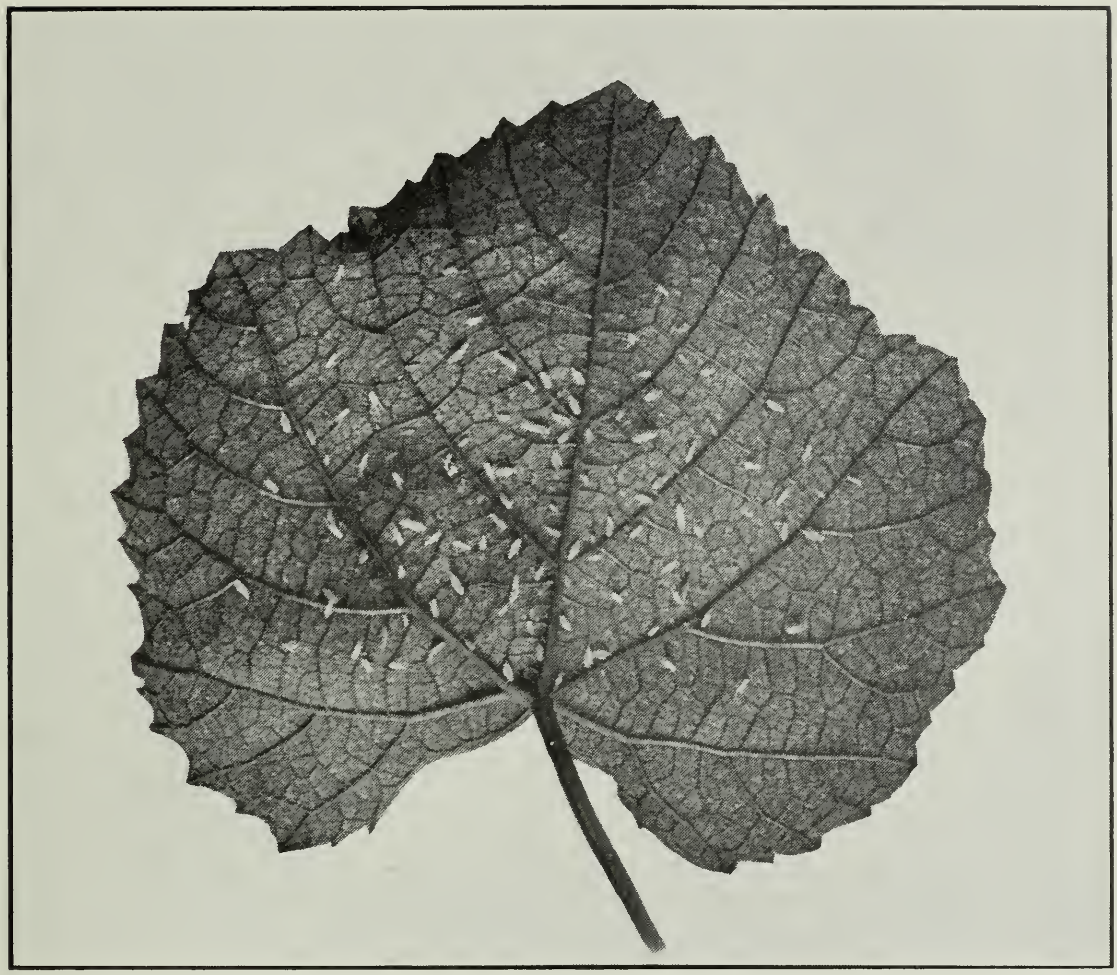


FIG. 14. Grape leaf hoppers on underside of grape leaf. (Courtesy Dominion Fruit Insect Laboratory, Vineland Station).

Grape Leaf Hopper

Leaf hoppers are the most important insect affecting the grape. There are several species differing in appearance, but the colour is usually yellowish, with brown, red and black markings; the body is about one-eighth-inch long, and slender. The adults pass the winter in long grass and weeds or under brush and leaves along headlands, roadsides and waste land, and make their appearance in the spring. When the grape leaves appear they migrate to them in large numbers and soon commence laying eggs.

The nymphs, or young, appear about mid-June to mid-July and are paler than the adults, usually cream colour. Both nymphs and adults live and feed on the underside of the grape leaves.

In some vineyards and in some seasons hoppers are relatively scarce, but in others they are innumerable and can injure the crop and vines severely. Small whitish spots appear on the upper surface of the leaves wherever the leaf hoppers feed and when hoppers are numerous the whole upper surface of the leaf becomes mottled, later turns brown and may die. If there is considerable injury the quality and maturity of the fruit is affected, and the vines will be weakened, thereby reducing the crop of the following season and making the vines liable to winter injury.

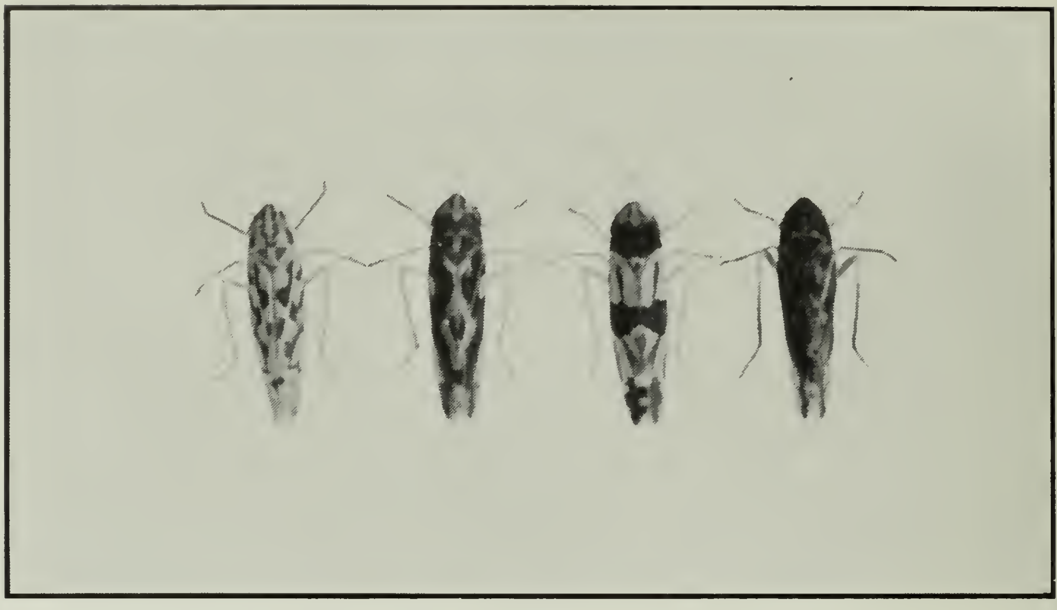


FIG. 15. Grape leaf hopper adults — greatly enlarged. (Courtesy Dominion Fruit Insect Laboratory, Vineland Station).

Grape Berry Moth

The berry moth occurs in all parts of the Niagara fruit belt but is destructive only in a few vineyards, particularly in Niagara, Grantham and Clinton townships. The berry-moth caterpillars are dark greenish or purplish and about three-eights-inch long when full grown. They web together and feed on the blossoms and newly set fruit, and a second brood attacks green and ripening fruit, tying the berries together with silken threads, boring through one berry to another and feeding on the pulp. Infested bunches show discolored and shrivelled berries and are worthless.

Grape Flea Beetle

This insect is not common and usually occurs in destructive numbers only in vineyards close to woods and waste land. The adults are steel-blue beetles about one-fifth-inch long and spend the winter under the shelter of rubbish near the vineyard, wild grapes, or Virginia creeper. They make their appearance in the spring when the buds are swelling, eat into the buds and completely destroy them. The larvae or worms are brown with black heads and many black spots on the back and are about one-third-inch long when full grown. They eat chainlike holes in the leaves. The adults also feed on leaves, but in most cases neither larvae nor adults do much injury to the foliage. Waste land and headlands where the adults winter should be cleaned up.

Rose Chafer

This insect breeds only in light sandy soils and so is troublesome only in such areas. The adults are yellowish brown or fawn coloured, long-legged, awkward appearing, somewhat slender beetles about three-eighths-inch long. The winter is spent as a grub in the soil; it changes to a pupa during the latter part of May, and the beetle emerges early in June a few days before Concord grapes bloom. The beetles soon fly to host plants, including grapes, where they feed on the leaves, blossoms and newly set fruit. When abundant they can easily destroy the whole crop.

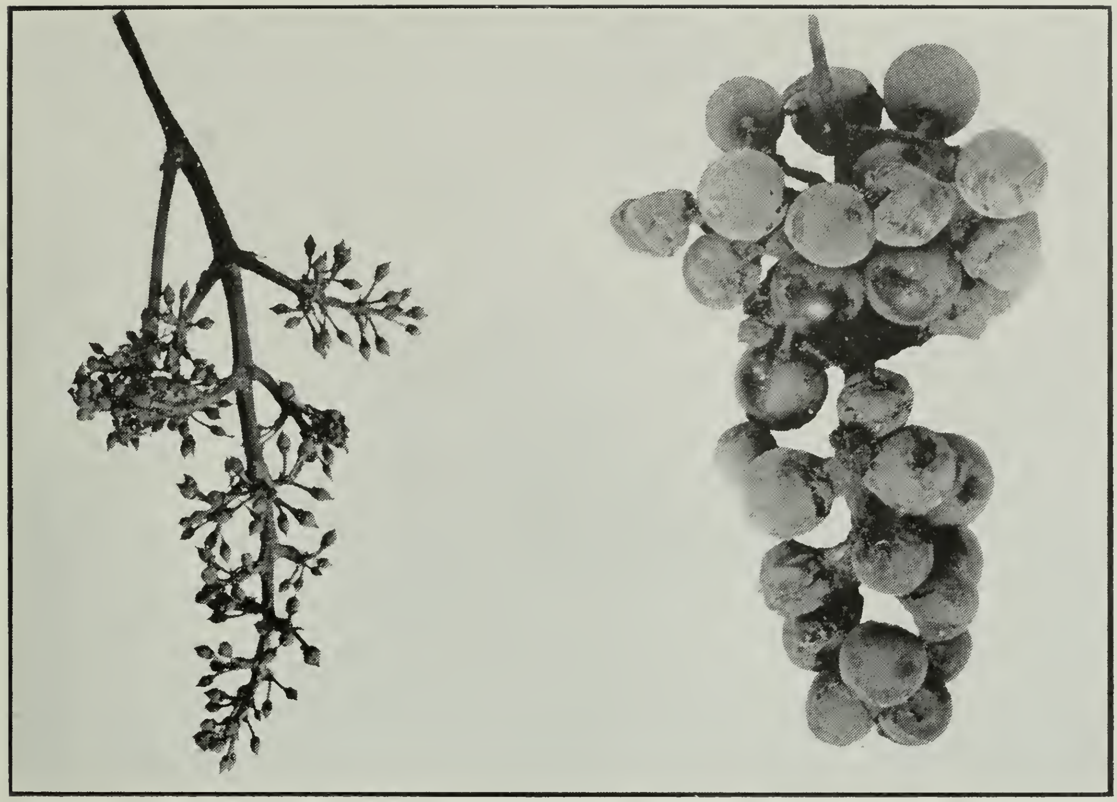


FIG. 16. (Left) Newly set cluster of grapes webbed together by grape berry moth. (Right) Bunch of grapes infected by grape berry moth. (Courtesy Dominion Fruit Insect Laboratory, Vineland Station).

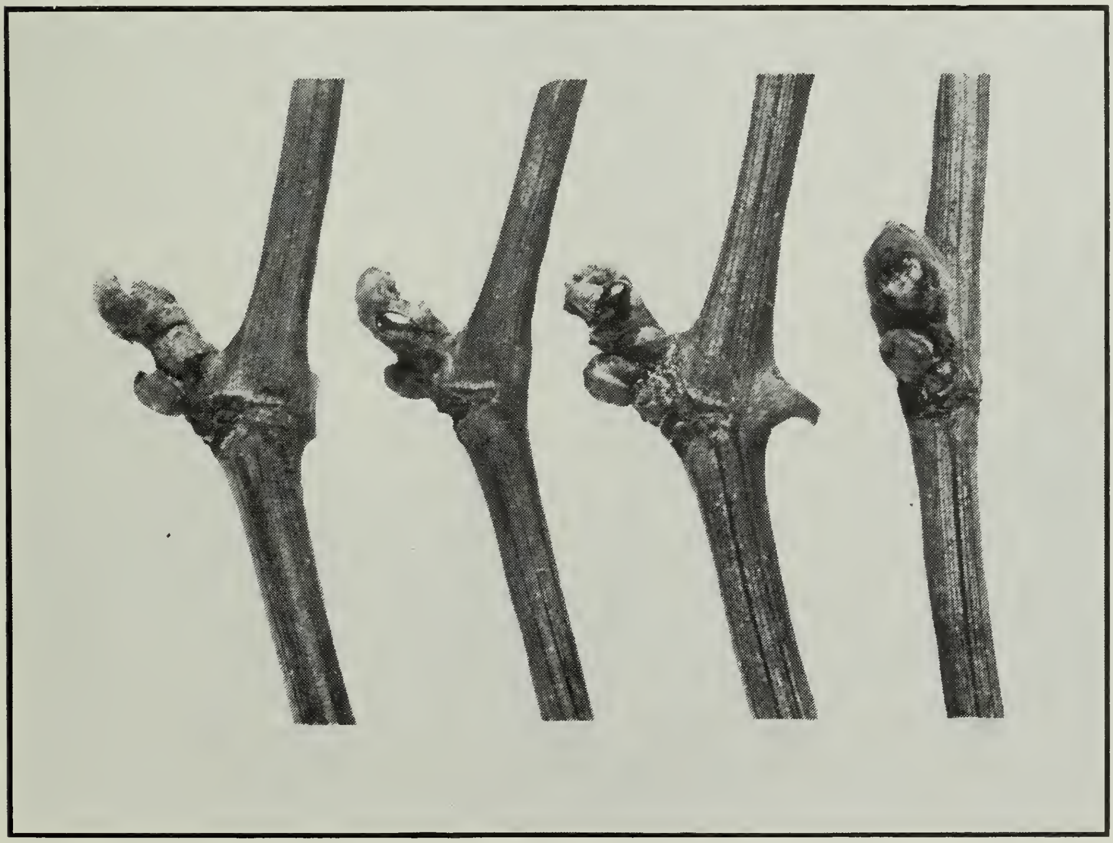


FIG. 17. Grape flea beetle attacking grape buds. (Courtesy Dominion Fruit Insect Laboratory, Vineland Station).

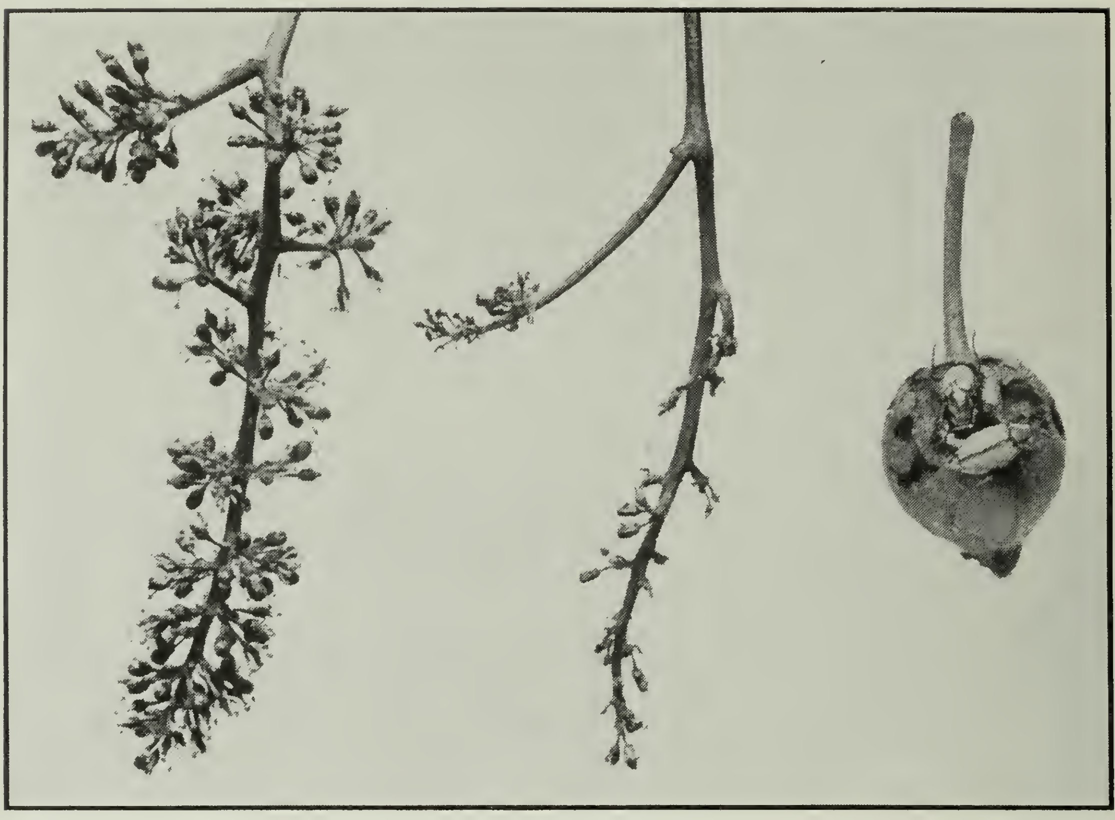


FIG. 18. (Left) Normal grape blossom cluster. (Centre) Blossom cluster destroyed by rose chafers. (Right) Rose chafers feeding on apple. (Courtesy Dominion Fruit Insect Laboratory, Vineland Station).

The rose chafer can be controlled. However it must be done on a community-wide basis if it is to be effective. The important breeding places, waste sandy land, grass land and neglected fields are first brought under cultivation and then seeded to clover or reforested. Infested fruit plantings must be cultivated thoroughly. In the vineyard itself, special sprays are effective in protecting the fruit against rose chafers coming from nearby breeding places.

Downy Mildew

This fungous disease is serious only in vineyards here and there and in wet seasons. Downy mildew attacks the young shoots, tendrils, leaves, blossoms and fruits. It is first seen on the leaves as irregular, pale yellowish blotches on the upper surface. These spots may increase in size or be so numerous that they run together and affect the whole leaf. The blotches later turn brown. A white, downy fungous growth develops on the under-surface of these spots if the weather has been damp. Whitish spots appear on the affected shoots which turn brown and wither if the disease is severe. If the berries are attacked when quite small, growth is stopped, the berry is covered with the white mildew and finally darkens and dries up. On larger berries, brown spots appear and increase in size, finally involving the whole berry which becomes shrunken and dark brown.

Powdery Mildew

Powdery mildew affects young shoots, leaves, blossoms and fruits. It is first seen as a circular whitish spot on both sides of the leaf. The spots may enlarge and run together until the whole leaf is affected. Badly mildewed leaves may be stunted and distorted. Mildewed blooms do not set fruit. Affected berries may cease to grow and drop, or develop irregularly and fail to ripen.

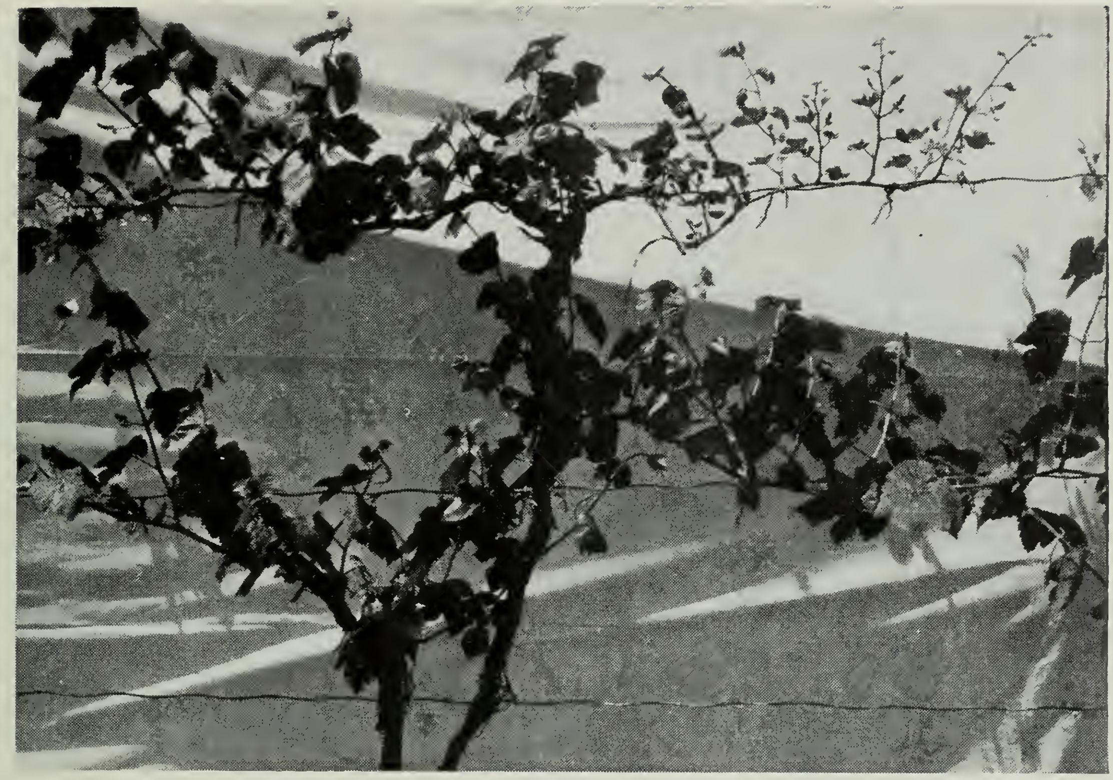


FIG. 19. Grape showing upper arm to the right with dwarfed, curled and crinkled leaves — typical symptoms of dead arm.

Black Rot

This fungus may attack leaves, tendrils, shoots, blossoms and fruits. Usually the disease does not attract attention until the half-grown berries start to rot. Light spots first appear on the berries; these enlarge quickly until the whole berry is affected and becomes a shrunken, black, hard mummy. The surface is covered with minute, black, pimple-like structures which contain the spores. The whole bunch or only a few berries may be affected.

On the leaves small, circular, brown spots with dark borders appear. Minute black specks may be seen on these spots.

Dead Arm

Dead arm occurs in most vineyards in the Peninsula and, in older vineyards particularly, it may be a very serious disease. On affected parts of the vine the buds fail to develop normally and shoot growth is weak or greatly delayed. When the shoots develop they are stunted, with shortened internodes and erect growth. The leaves on these shoots are small, cupped, yellowish, and crinkled on the margin. These symptoms are particularly noticeable during June and early July. Later in the season many of the affected leaves drop and secondary leaves develop which appear healthy and mask the early symptoms, leading the grower to believe the vine is recovering. Once attacked, vines never recover and eventually the arm is completely killed and, as the disease extends down the trunk, the whole vine becomes affected.

It is felt that, in the past, inspections have been made too late, and that many diseased plants have been missed and left to act as a source of inoculum

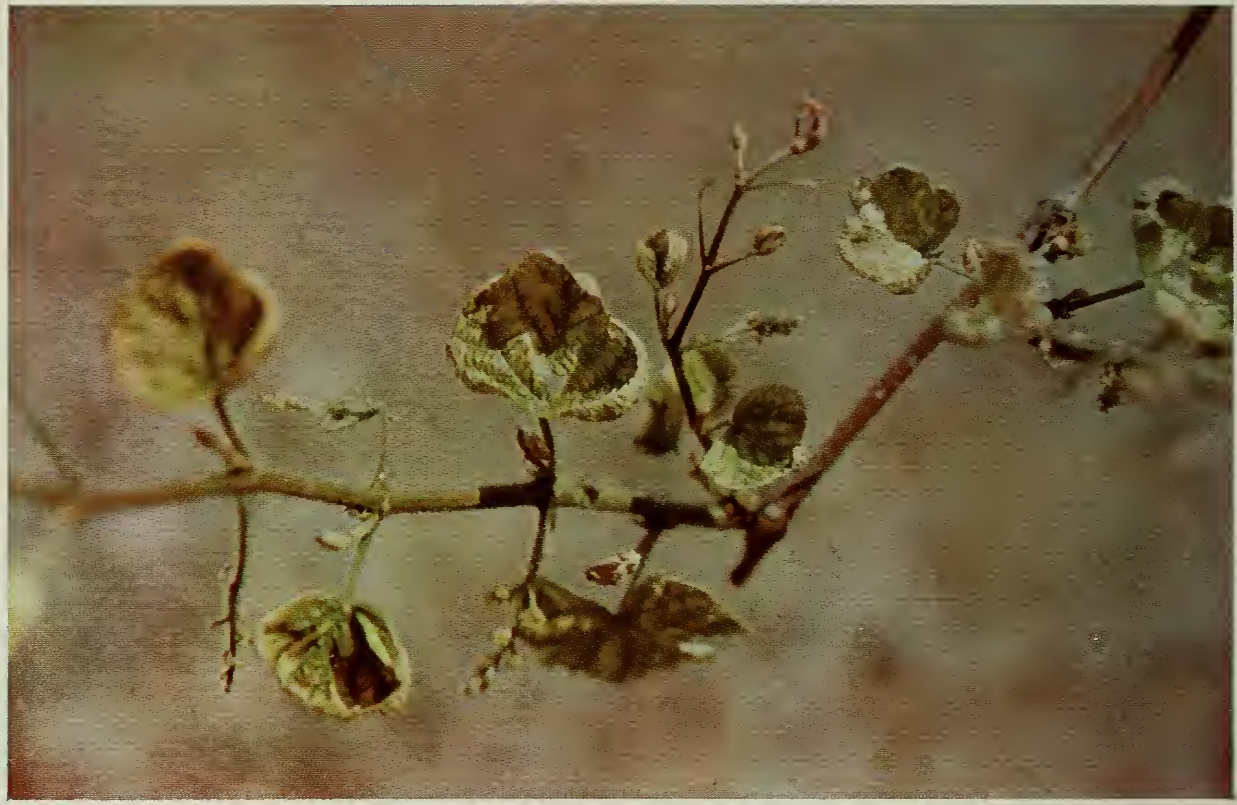


FIG. 20. Close-up of shoot affected with dead arm, showing small, cupped and yellowish leaves, which are crinkled on the margin.

for further infections. Since the more reliable symptoms are the failure of the buds to develop normally, and the weak or greatly delayed shoot growth, an early inspection should be made and the diseased wood removed immediately. This should give better control than delaying the removal to the following pruning season, as has been the practice.

The infected arms bearing the lesions should be removed. In the case of trunk infection, this involves pruning well below the infection, usually to the first wire. By carefully examining the trunk around stubs particularly, the extent of a lesion can be noted and the vine pruned well back of the affected part. Periodic renewal of vines (see page 19) more than ten years old will help keep the disease in check.

Chlorosis

During the early summer in some vineyards, the foliage of an occasional vine will turn yellow. Sometimes this condition is mistaken for dead arm. In contrast to dead arm, vines showing this chlorotic condition have leaves of normal size and usually the whole vine is affected. Vines may be spotted here and there in the vineyard although the condition is sometimes localized.

This condition is not caused by any fungus, bacterium or insect, but appears to be due to nutritional factors. As the season advances affected vines will usually regain their natural colour, and the crop is not very adversely affected.

Where this condition is extreme, spraying with 5 pounds of manganese sulphate per 100 gallons of water has sometimes been beneficial.

BULLETIN No. 488 APRIL, 1952

EXHIBITING AND JUDGING VEGETABLES

•

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

PAGE

GENERAL CONSIDERATIONS 3
RULES AND REGULATIONS 3
  Prize Lists 3
  Labelling 4
  Display Receptacles 5
SELECTING SPECIMENS FOR COMPETITION 5
IMPORTANT SHOW POINTS 5
ASPARAGUS 6
BEANS 6
  Snap Beans 7
  Runner Beans 7
  Broad and Lima Beans 7
BEETS 7–8
BROCCOLI (SPROUTING) 8
BRUSSELS SPROUTS 10
  Plants 10
  Picked Sprouts (removed from stalks) 10
CABBAGE 11
CARROT 12
CAULIFLOWER 13
CELERIAC 14
CELERY 14
CHARD (SWISS CHARD) 14
CITRON 15
CORN, SWEET 15
CUCUMBER 16
  Slicing Type 16
  Pickling Type 16
EGGPLANT 17
ENDIVE 17
KALE 17
KOHLRABI 18
LEEK 18
LETTUCE 18
  Crisphead and Butterhead Types 18
  Cos Type 18
  Leaf Type 19
MUSKMELON (CANTALOUPE) 20
ONION 20
  Mature Bulbs 20
  Pickling Onions 21
  Green-Bunch Onions 21
PARSLEY 22
PARSNIPS 22
PEAS 22
PEPPERS 23

CONTENTS (Cont.)

PAGE
POTATOES 24
PUMPKIN AND SUMMER SQUASH 26
RADISH 27
RHUBARB 27
SPINACH 27
SQUASH (WINTER) 28
TOMATO 28
SWEDE TURNIP (RUTABAGA) 30
VEGETABLE MARROW 31
VEGETABLE COLLECTIONS 31
WATERMELON 31

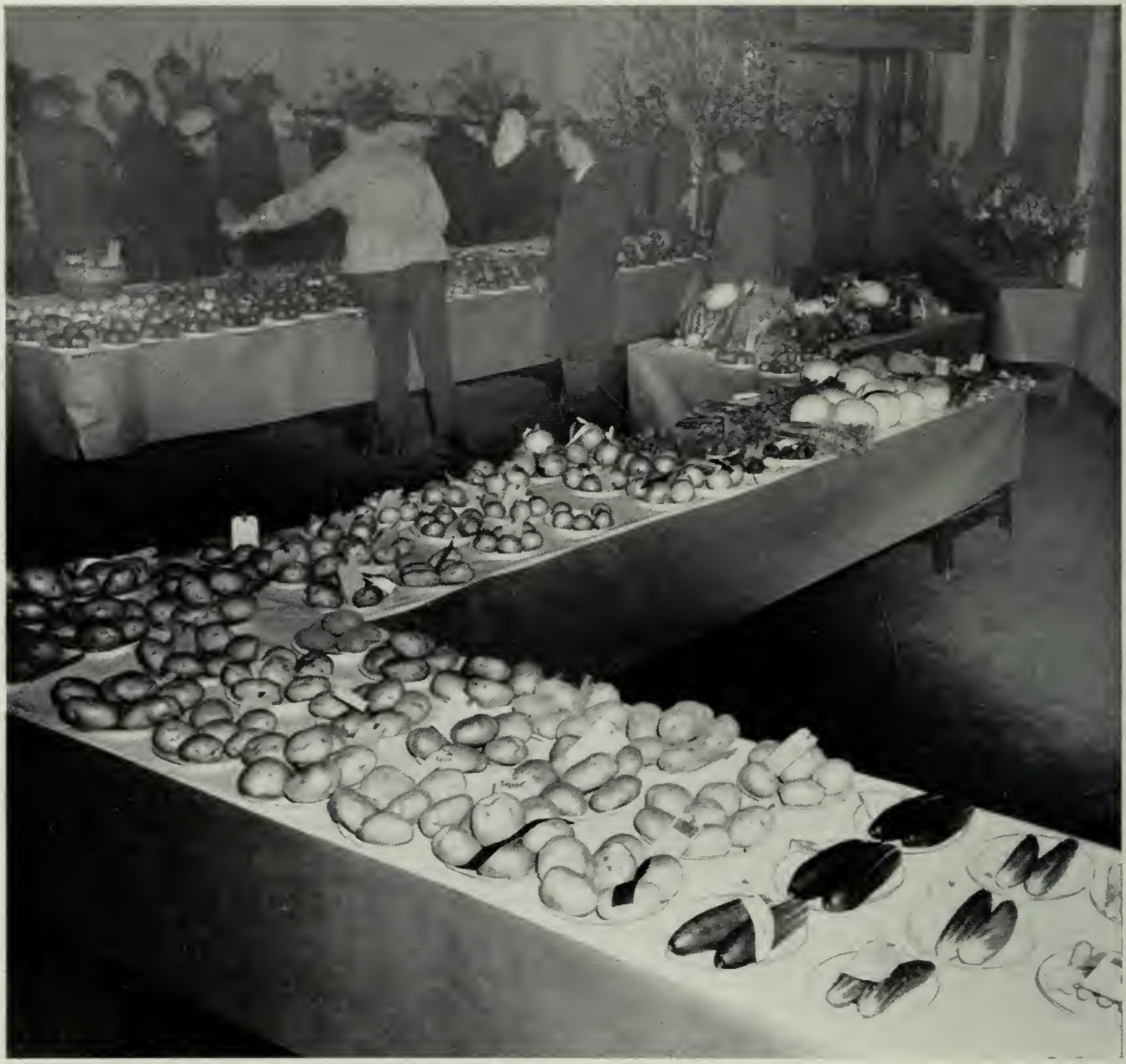


Fig. 1. A view of a part of the horticultural section in the College Royal at the Ontario Agricultural College.

EXHIBITING AND JUDGING VEGETABLES

by

T. H. JONES and J. S. SHOEMAKER

Department of Horticulture, Ontario Agricultural College, Guelph, Ontario.

GENERAL CONSIDERATIONS

The main objects of horticultural shows are: (a) educational; (b) through competition, to inspire growers to improvements in their crops; and (c) to promote pride in the produce grown in the community. Vegetables comprise an important part of most horticultural shows.

The commercial grower is interested in sales and profits. He chooses the varieties that yield best and most nearly meet the market preferences. He is interested in the proper degree of maturity, in the best methods of preparation for market, and in practical grading and packing. He is only indirectly interested in food values or in balanced diets. The home gardener, on the other hand, cares little about the market or market preferences, since he does not intend to sell any products out of his garden. He is interested in quality as expressed in flavour, texture, and palatability. He plants a garden to provide his family with an adequate supply of a wide assortment of high-quality vegetable foods.

The emphasis is placed in this bulletin on suggestions for shows of small to medium size. However, the points set forth will apply in most cases, whether the show be small, medium, or large in size.

RULES AND REGULATIONS

The rules and regulations under which vegetable and related shows are held vary with many circumstances, including the size of the show, the range of products exhibited, and the value of the awards. They should be complete enough, however, to guide all concerned in its conduct, be clearly and plainly stated, and be prominently printed with the schedule, or prize list, of the organization holding the show.

Awards should not be made to unworthy entries though they may be the only ones of their kind on exhibition. To give such an entry a prize is to defeat the purpose of the show.

Prize Lists

The success of an exhibition is dependent greatly upon the preparation of a clear, accurate catalogue of well-selected entries. The vagueness and ambiguity of many catalogued lists of vegetable crops and the classes for which prizes are offered lead to misunderstandings and unwise compromises and concessions. The schedule should clearly indicate the kind, and preferably the variety, of vegetables for each class; the number of kinds, or varieties, if a collection; the form in which crops are to be shown; the date entries are closed; the hour when exhibits must be ready for judging; and other particulars that are necessary for the guidance of exhibitors and judges.

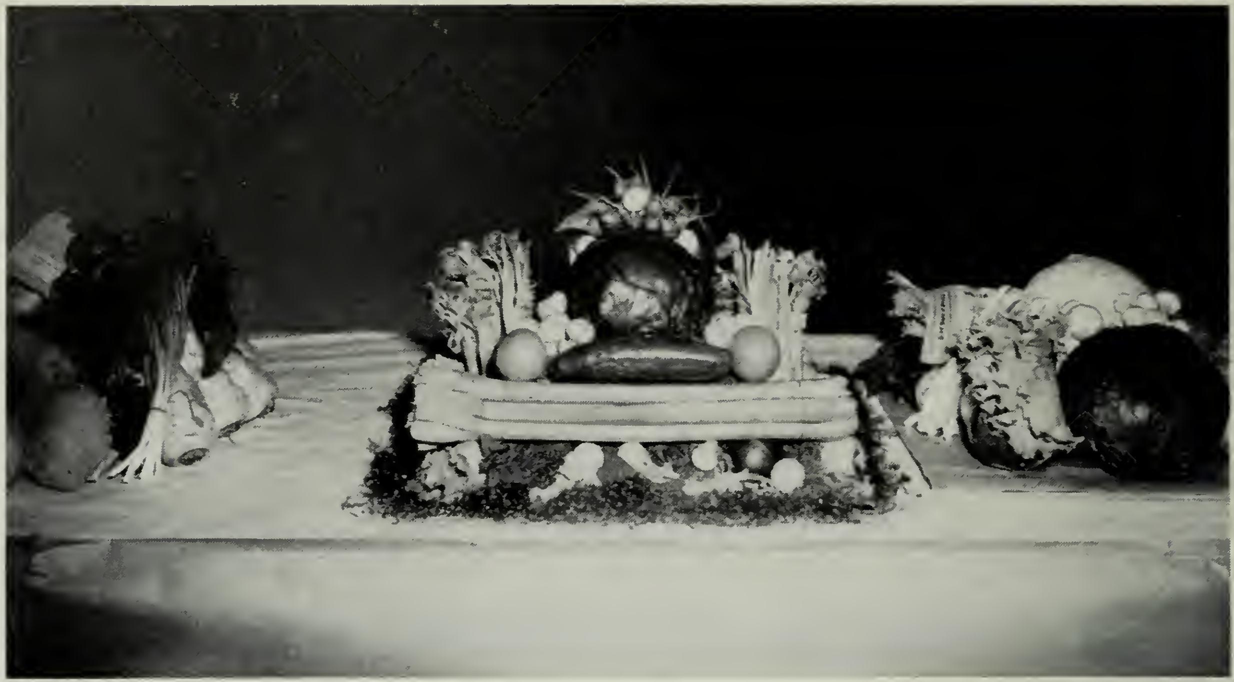


Fig. 2. A small, compact entry of a collection of vegetables.

The listings must be accurate and carefully selected, and should include only kinds or varieties that possess horticultural standing in the region. When a certain variety is called for, a specimen of another variety mixed with it disqualifies the entry.

The number of specimens per entry mentioned for each vegetable in this bulletin is suggestive in a general way and may be modified to advantage according to the size of the show and other factors. The quantity or number required should be definitely stated in the prize list. Where a definite number of specimens is required, variation from this number may disqualify the entry.

Labelling

A vegetable exhibit in which varieties are not labelled lacks greatly in educational value. Few spectators know the difference, for example, between Chantenay and Nantes carrots, and learn very little if the varietal names are not shown. Each exhibitor may be required to name the variety or varieties entered. But using labels to indicate varieties which may be so similar that even the judge is not sure only adds to confusion and does not accomplish much of benefit to anyone. Labels should be used to designate classes.

The committee in charge of exhibits should supply uniform and neat cards or labels together with pins, stickers, or other devices for attaching them to the specimens or entries. All variety labels should be attached in a uniform manner.

Display Receptacles

Vegetables are often displayed not only in insufficient space but in a confusing disarray of inappropriate and inadequate receptacles. Such exhibits fail to arouse proper interest. Uniform trays, plates, and other containers, of such sizes and shapes as display the vegetables to best advantage, should be provided by the show management.

SELECTING SPECIMENS FOR COMPETITION

No exhibitor can hope to win against worthwhile competition if he does not choose his specimens carefully. It is wise, from the largest number of specimens available, to choose those which most nearly approach the type for the particular entry. A good plan is to select a few alternate specimens to replace any that become injured, lost, or over-mature.

In general, slightly above medium size should be selected in preference to the largest. Over-grown specimens are rarely typical and usually they are coarse in texture and lacking in flavour (watermelon, citron, pumpkin, winter squash, eggplant, and sometimes onion, are exceptions). The best stage of maturity is determined to some extent by the length of time the exhibit is to stand, but immaturity and over-maturity should be avoided.

Other conditions being equal, and varieties considered, specimens with the more intense or deeper shades of colour are preferred. Pure white cauliflower is preferred to the ivory-white shade. Dark-green spinach is preferred to the lighter-green. The deep-yellow muskmelon is preferred to the lighter-yellow specimens of the same variety. Uniformity is also very important and expresses itself in many ways, for example, in size, shape, degree of maturity, and colour.

IMPORTANT SHOW POINTS

In all the score cards a point value of "Freedom from Blemish" is omitted. This item is included in the score cards under "Condition". Blemish includes decay, damage caused by dirt, disease, insects, and mechanical or other means. In some cases the blemish may be so severe that the entry should be disqualified.

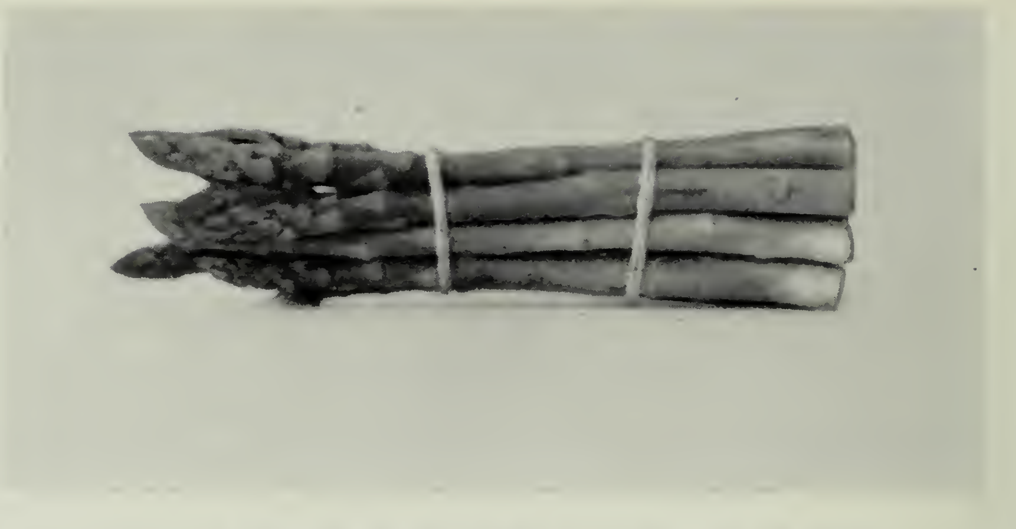


Fig. 3. Asparagus spears should be tied neatly in a bunch.

ASPARAGUS

Most shows are held much later than the normal season for asparagus. Therefore, to obtain show specimens it might be necessary to keep the plants continuously cut back. This is an undesirable practice as it weakens the plants and reduces the next year's yield.

An asparagus entry should be tied in a bunch of 1 pound, or of 10 spears, unless otherwise stated in the prize list, with the butts even. The tying material, *e.g.* ribbon, cord, or rubber band, should be placed both near the base and slightly below the tips.

Score Card for Asparagus

Uniformity and type	35
Condition (freedom from blemish)	25
Tenderness	15
Size	15
Colour	10

The spears should be well-matched, evenly trimmed, fresh, tender, crisp, straight, unbranched, thick, and of medium length (6 to 8 inches). The tips should be sound, tight, and closed. Not more than 1 inch of white should show at the bottom. The size and colour should at least meet the requirements for the highest grade; that is, the base of each stalk should exceed 3/8 inch diameter, the length not less than 5 3/4 inches, and 85 per cent of that length must be green.

BEANS

Each entry in pod classes should consist of 12 pods or in the case of shell beans 1 pint. The required number or amount should be stated in the prize list and if not the exhibitor should use the number or amount stated.

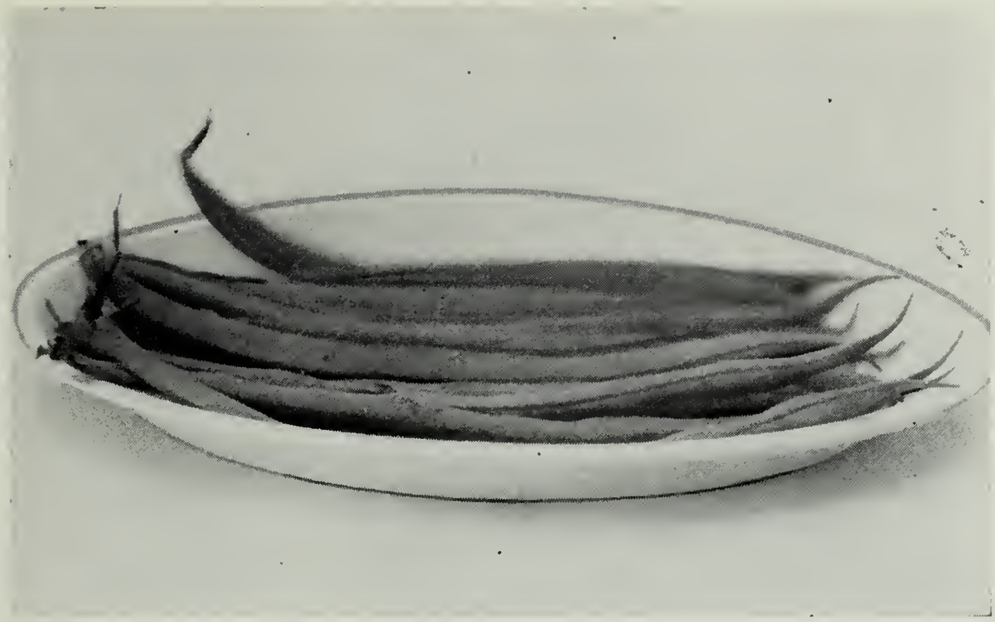


Fig. 4. A plate of snap beans.

Snap Beans

The pods should be well-matched in all characteristics, and should be of a good colour, clear, brittle (snap if bent), free from stringiness, fresh, fine-grained, smooth, fleshy, clean, and well filled. The seed should be tender, yet well-formed. The specimens should not be washed.

Score Card for Snap Beans

Uniformity and type	35
Condition (freedom from blemish)	25
Fleshiness and brittleness	25
Colour	15

Runner Beans

The pods should be well-matched, deep-green, long, brittle, not stringy, reasonably straight, and typical of the variety. The seeds should be about half size.

Broad and Lima Beans

The pods should be well-matched, bright in colour, smooth, well filled with beans in a fresh, edible condition. In the case of broad beans, the long-pod and Windsor types should be placed in separate classes. Green-shell lima beans to be shown in the pod should be picked as soon as the seeds reach full size and before they begin to ripen.

BEETS

There should be separate classes for topped roots and bunched specimens. The standard number of specimens per entry is 5 roots in topped classes, and 6 beets per bunch. In topped classes, the tops should be removed ½ inch or somewhat more above the crowns. Very close trimming is undesirable. Beets may be placed in cold water preparatory to the dirt being carefully wiped off, except in storage classes which should not be washed.

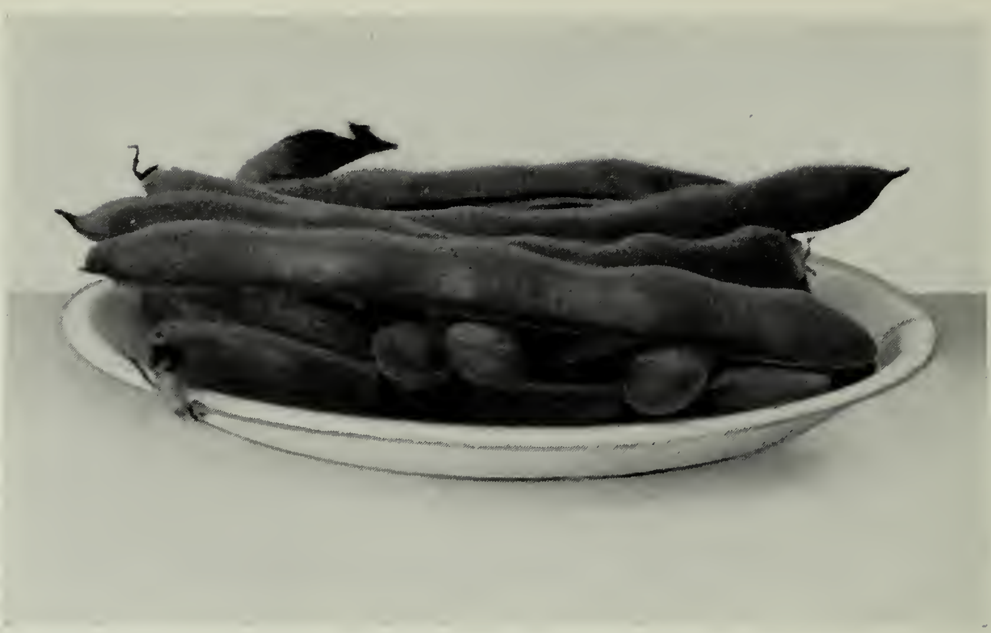


Fig. 5. The long-pod type of broad bean.

The specimens should be well-matched and firm. The outer appearance should be attractive and the surface smooth with few or no side roots. The flesh should be crisp, tender, dark-red, with closely spaced rings and free from white colour. The round type should be deep, with a small taproot, and the long type should taper gradually and evenly to the tip. In topped classes, a 2 to 2¼ inch diameter size is preferred. When bunched, the specimens should be about half-grown, immature, and succulent, of good colour, and the leaves must be healthy.

Score Card for Beets

Uniformity and type	30
Condition (including freedom from blemish)	25
Flesh colour and tenderness	20
Outer colour and smoothness	15
Freedom from side roots	10

The question of method of determining colour is a contentious one. The outside colour of the beet does not correctly indicate the colour of the flesh. To cut all specimens in half detracts from the appearance of the exhibit, and, although the most accurate practice, it should be avoided because the beets are unsightly in appearance for the spectators at the show. The taking of a small section from each specimen of each entry when the various exhibits are in close competition, is a satisfactory practice, and exposes only the uncut portion of each beet if the specimens are subsequently arranged with the cut surface hidden from view.

BROCCOLI (Sprouting)

The score card for cauliflower may be used for sprouting broccoli.

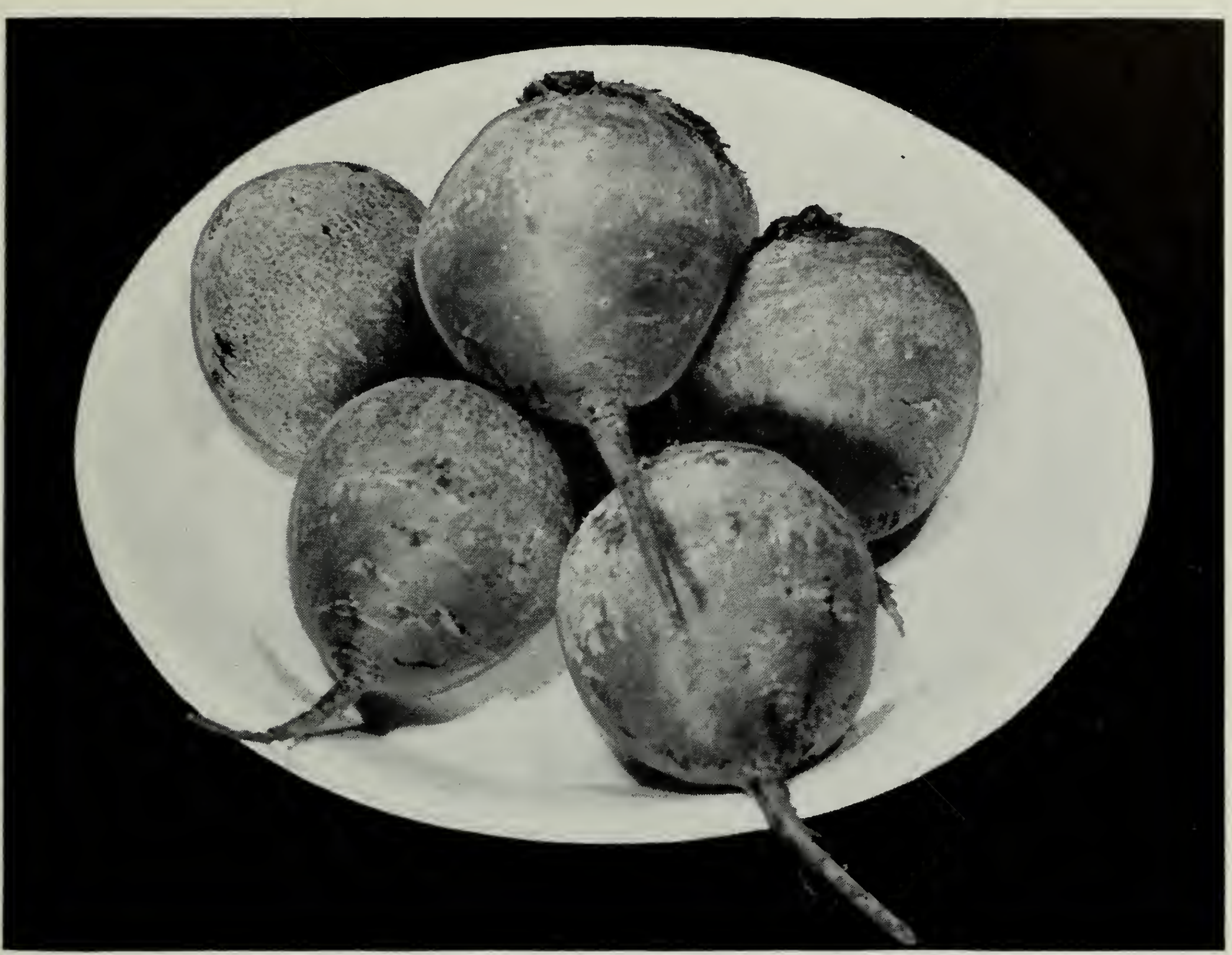


Fig. 6. Prize-winning entry of topped beets. (Simcoe Fair.)

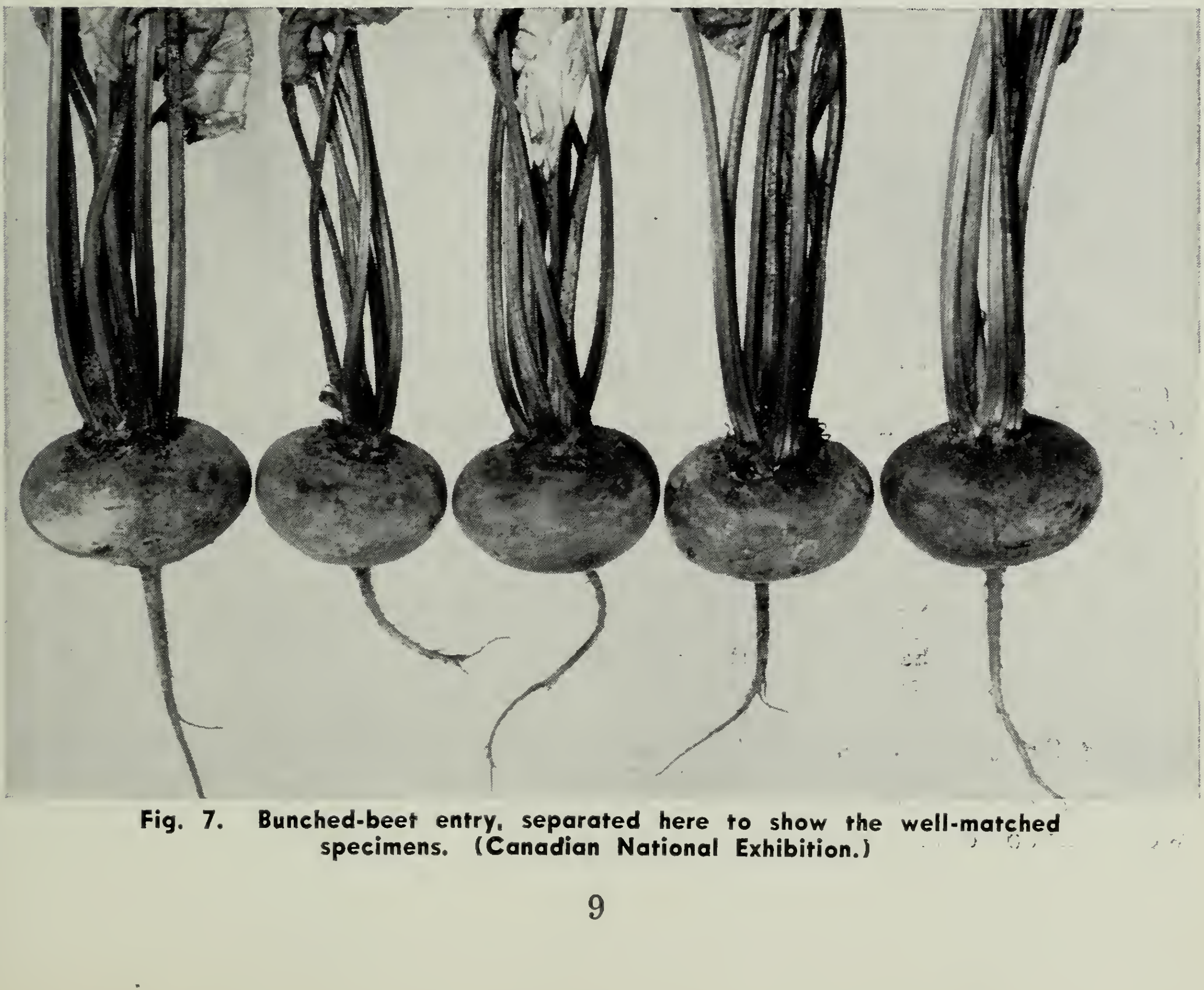


Fig. 7. Bunched-beet entry, separated here to show the well-matched specimens. (Canadian National Exhibition.)

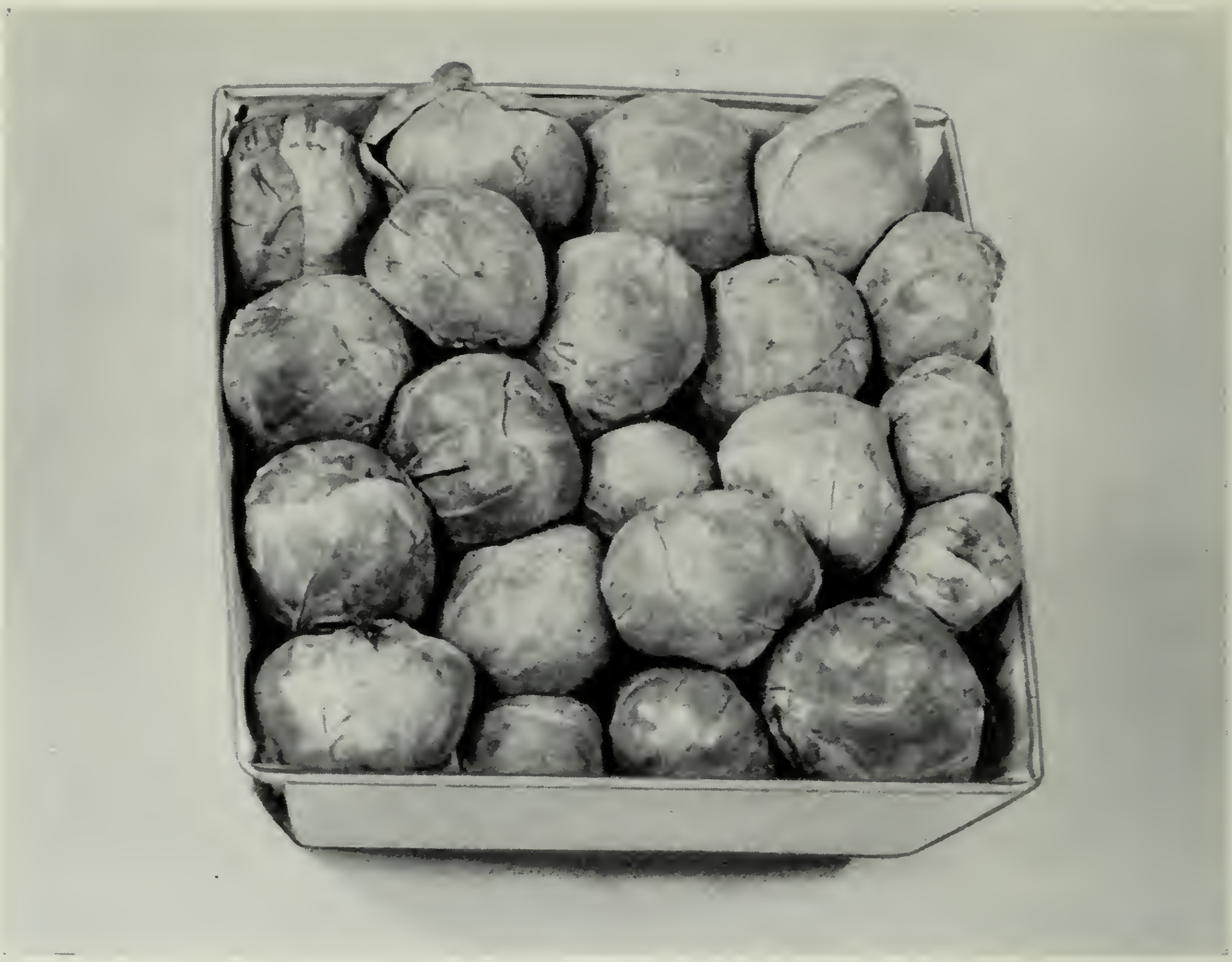


Fig. 8. Brussels sprouts removed from the stalk.

BRUSSELS SPROUTS

Each entry should consist of 2 stalks. Or, 1 pint is the standard amount when the sprouts are shown removed from the stalk.

Plants

Numerous, medium-sized, firm, well-formed sprouts should be compactly situated on a straight main stem, and the sprouts should be regularly developed progressively from the bottom upwards. The terminal leaves should remain on the main stem, and the lateral leaves should be removed.

Score Card for Brussels Sprouts
(*removed from stalks*)

Uniformity and type	35
Condition (including freedom from blemish)	25
Firmness	20
Shape of sprouts	10
Size of sprouts	10

Picked Sprouts *(removed from stalks)*

The sprouts should be uniform, medium in size, heavy, firm, round, well-shaped, compact, clean, and of attractive green colour.

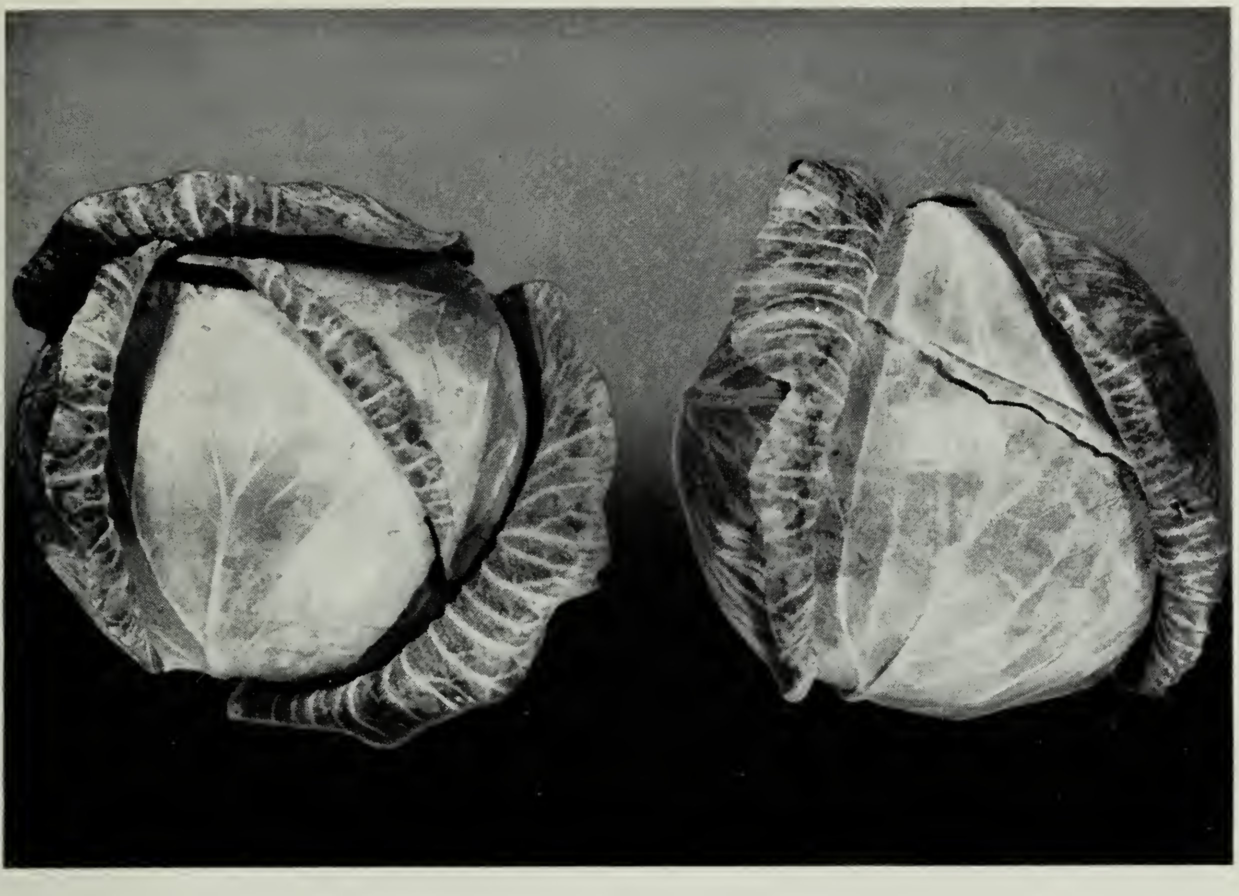


Fig. 9. Cabbage entry. (Simcoe Fair.)

CABBAGE

The standard entry is 2 heads. Desirable features in show cabbage are well-matched specimens with heads that are solid, firm, fresh, crisp, and tender. The heavier specimens, other conditions being equal, receive preference. The stem should be trimmed to be no longer than ½ inch and the heads should be trimmed down to two layers of sound, green, outer leaves. Only the large, loose, or spreading outer leaves should be trimmed off in storage specimen classes.

Score Card for Cabbage

Uniformity and type	25
Firmness	20
Condition (including freedom from blemish)	20
Size of head	15
Colour	10
Crispness	10

The Savoy cabbage type should be of medium size (8 to 10 inches diameter) and with a fine or close curl to leaves. The heads should be firm, but the same degree of firmness is not expected as in the more common types.

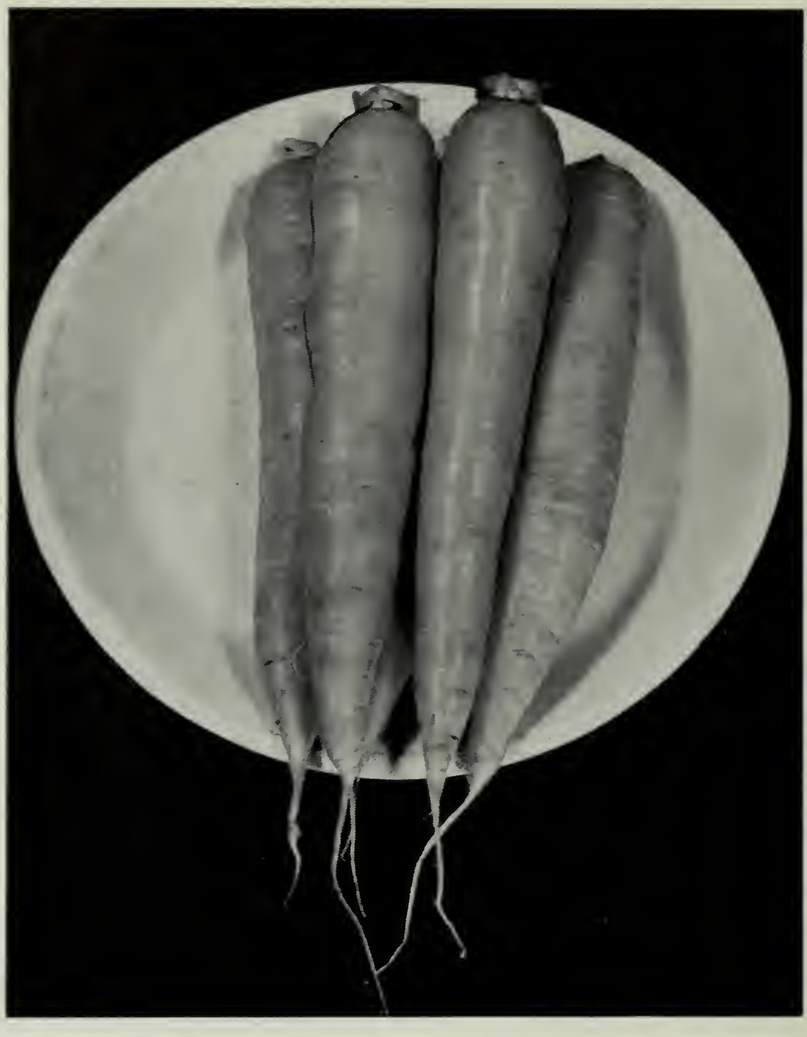


Fig. 10. Carrot entry. (Owen Sound Fair.)

CARROT

The standard entry is 6, sometimes 5, specimens (roots). There should be 6 carrots in each bunch when shown as bunched carrots. Carrots may be exhibited as long, half-long, or short varieties, in separate classes. The prize list should state whether topped or bunched specimens are required, and if the leaves are to be trimmed. In topped classes, the tops are removed ½ inch above the crown. The roots, if washed, should be washed carefully with a soft cloth. When shown as storage crops, the roots should not be washed.

Score Card for Carrots

Uniformity and type	30
Condition (including freedom from blemish)	30
Form and colour	25
Size	15

The specimens should be: well-matched, firm, taper gradually from crown to tip, and have a smooth surface with no side roots and no green colour at the crown. The flesh should have a large outer ring, a small core, be deep orange in colour throughout, and be fine and tender in

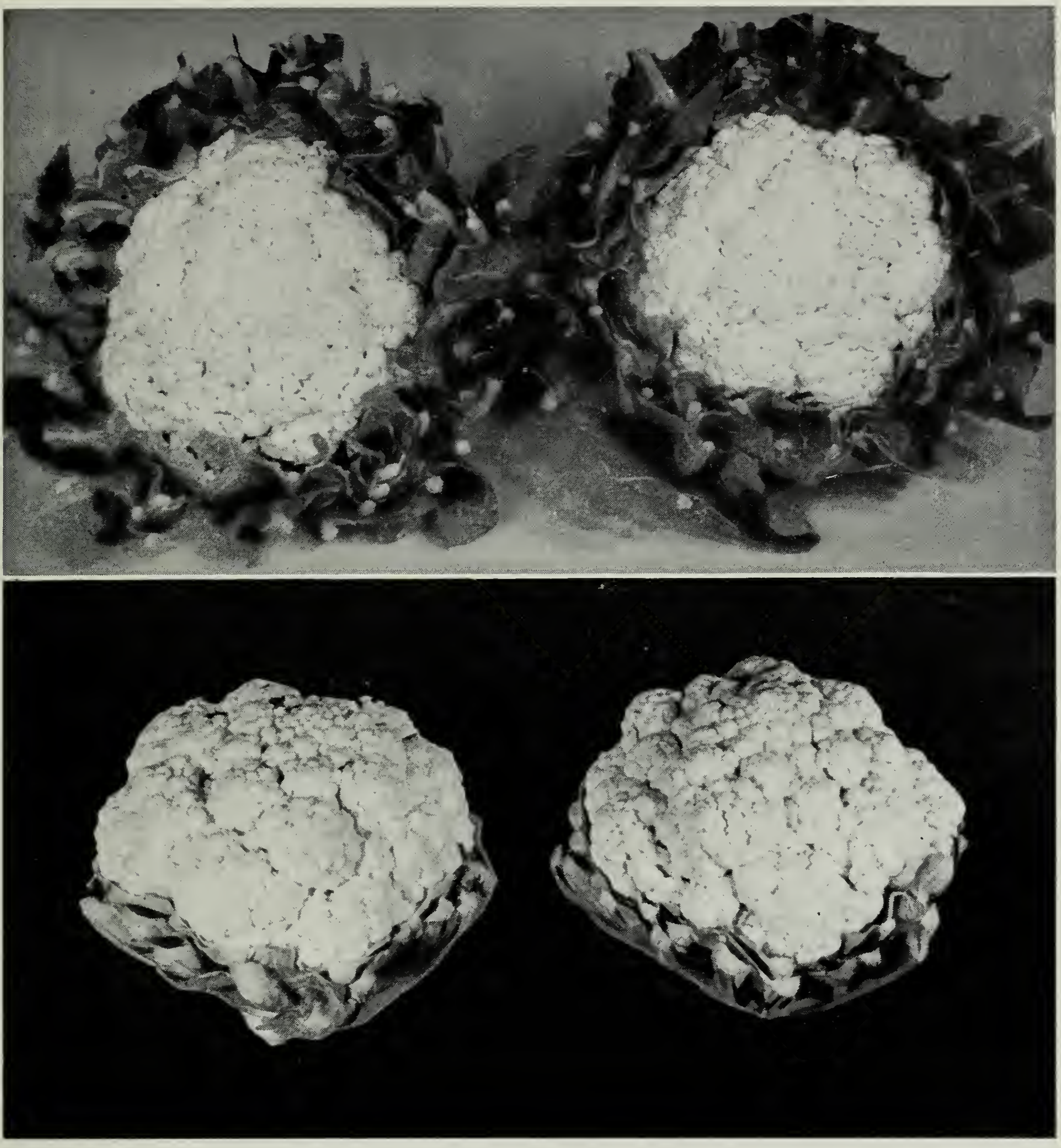


Fig. 11. Two entries of cauliflower. The method of trimming shown at the top is preferred.

texture. The taproot should be present. When bunched, the specimens should be succulent, and somewhat larger than half-grown.

According to the Ontario Farm Products Grades and Sales Act 1951 the grade for Canada No. 1 topped carrots is "of minimum length of 3½ inches, of a minimum diameter of 1¼ inches and a maximum diameter of 2½ inches".

CAULIFLOWER

The standard entry is 2 heads. These should be well-matched, pure white, smooth, clean and firm. The head formation should be dense, regular, well formed, and free from fuzziness and small leaves.

Score Card for Cauliflower

Condition (including freedom from blemish)	25
Uniformity and type	20
Colour of curd	20
Form and density of curd	20
Size of head	15

A few (4 to 6) of the lower leaves should remain around the head or curd (the prize list should give directions) and should be trimmed squarely across, leaving ½ to 1 inch projecting above the head. The stem should be cut off short.

CELERIAC

The standard entry is 2 specimens. These should be well-matched, medium in size, white-fleshed, firm, heavy and round.

CELERY

The standard entry is 3 plants. The plants should be dug just before the show and washed with water.

Desirable features in show celery are well-matched, large, firm heads with well-developed hearts that extend to a good length but are free from any seedstalk development. The outer stalks should be large, closely set, and free of prominent ribs, rust spots, and other blemishes. All stalks should have solid, tender flesh of a sweet flavour and free from strings. Small and broken outer stalks should be removed. White and yellow varieties should be well blanched but green varieties may be shown without blanching. The roots should be neatly trimmed in a circular manner. (Commercial entries of celery may be trimmed squarely across the base.)

Score Card for Celery

Uniformity and type	25
Condition (including freedom from blemish)	25
Crispness	20
Colour	10
Ribbing	10
Size	10

According to the Ontario Farm Products and Sales Act, 1950, the grade for Canada No. 1 celery is, in part, as follows :"at least 15 inches in length where the tops have been clipped back and at least 18 inches in length where the tops have not been generally clipped back"; "well trimmed means—(i) that the outside coarse and damaged branches have been removed, and (ii) that the portion of the main root remaining is not more than 3 inches in length except celery intended for storage".

CHARD (Swiss Chard)

The standard entry is 2 specimens, or a bundle of 3 specimens. The roots should be removed. Only succulent, uniformly-coloured stems (with leaves attached) should be exhibited.

Score Card for Chard

Uniformity and type	25
Condition (including freedom from blemish)	20
Tenderness	20
Colour	15
Length of stalk	10
Thickness of stalk	10

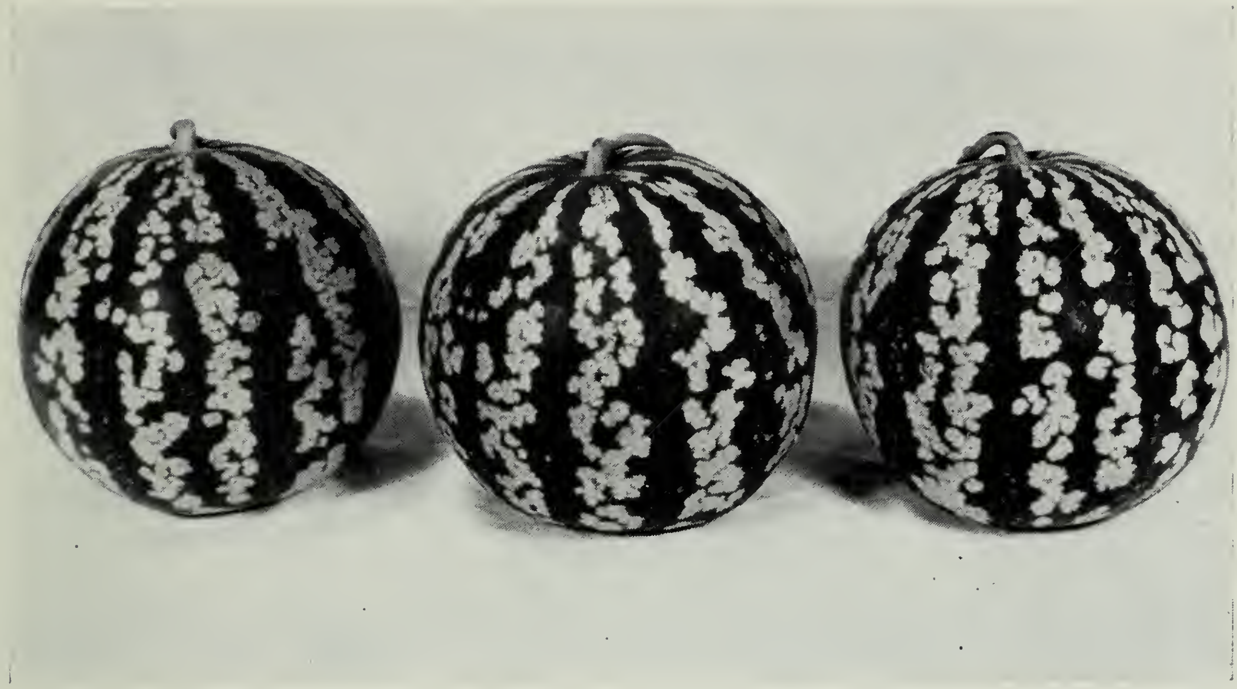


Fig. 12. Citron. (Canadian National Exhibition.)

Desirable features in show chard are specimens that are well-matched in size, form, colour, and other characteristics; leaves that are deep green, large, broad, tender, not wilted; and, stalks that are long, broad, straight, and free from stringiness.

CITRON

The standard entry is 3 specimens. These should be well-matched, large, well-rounded, heavy, finely mottled, uniformly coloured, and firm.

CORN, SWEET

The standard entry is 6 ears. Open-pollinated varieties should be shown in different classes from the hybrids. In the open-pollinated varieties, there should be separate classes for Golden Bantam (8-rows) and for varieties with more than 8 rows of kernels.

Score Card for Sweet Corn

Uniformity and type	25
Condition (including freedom from blemish)	20
Colour of kernels	15
Tips and butts	15
Tenderness	15
Rowing of kernels	10

Desirable features in show sweet corn are well-matched specimens that are typical of the variety, with the ears well-filled from tip to butt, and of a deep colour. The kernels should be well-filled, evenly and closely spaced, and well-rounded. There should not be wide spaces between rows of kernels. The pre-dough stage of maturity is desirable but in view of the rapid deterioration in quality of corn after harvest and the limitations involved in preparing an exhibit ears which have passed the best edible stage are acceptable in some cases.

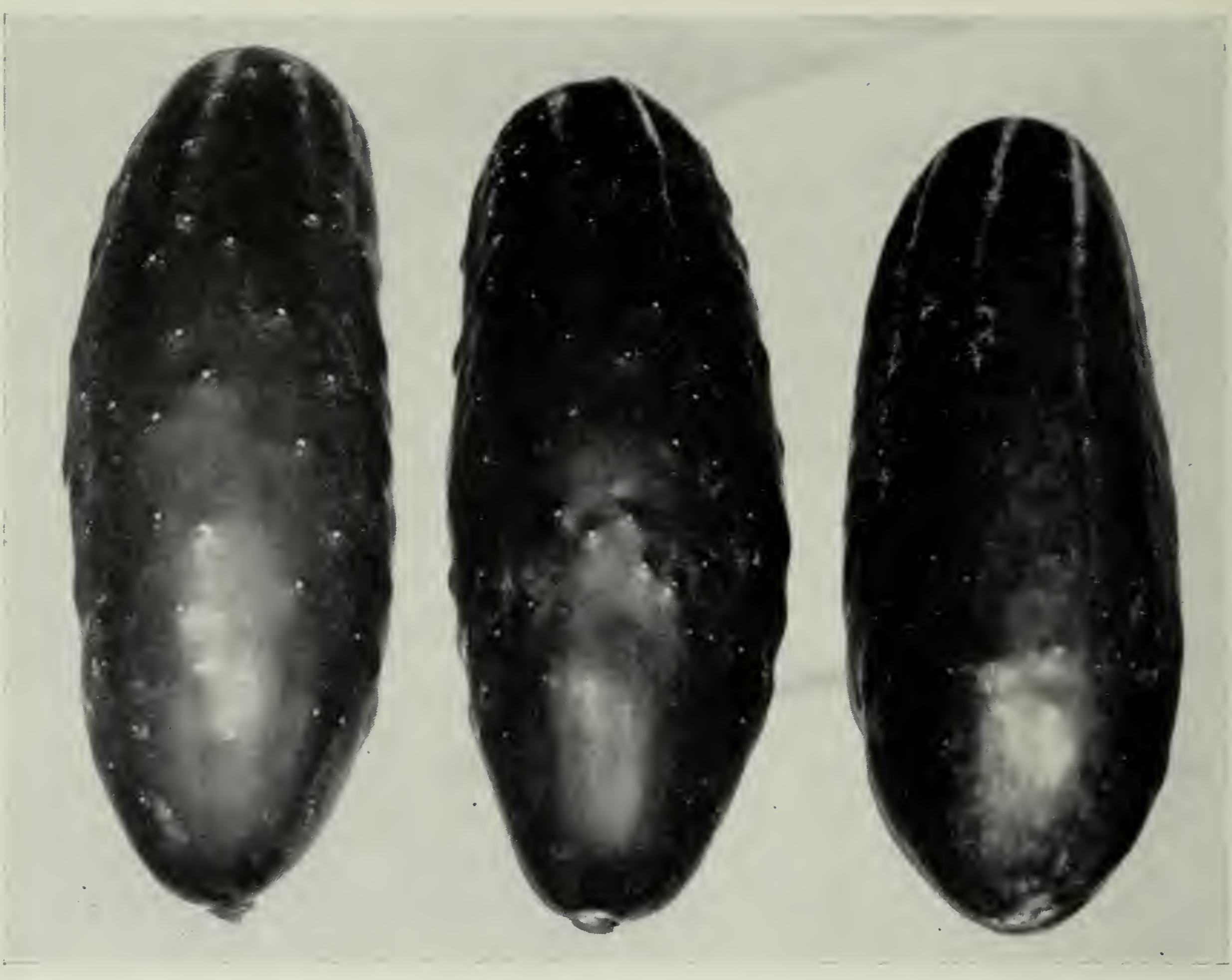


Fig. 13. An entry of the standard number of 3 specimens of slicing-type cucumbers.

CUCUMBER

The standard entry is 3, sometimes 2, specimens of slicing kinds, and 1 quart or 24 specimens when shown for pickling purposes. Washing is permissible.

Slicing Type

Slicing cucumbers should be well-matched specimens, not over 9 inches long, not over-ripe, and of a straight, even shape with blunt ends. The colour should be dark-green, and surface smooth or warted (according to the variety). The flesh should be thick, tender, crisp, and free of any green colour. Long varieties should be shown in a separate class.

Score Card for Cucumber
(slicing type)

Uniformity and type	25
Condition (including freedom from blemish)	20
Form	20
Size	15
Colour	15
Spines	5

Pickling Type

Pickling cucumbers should be well-matched, small, uniform, deep-green in colour, and of even diameter from stem to blossom end. There should be a separate class for dills.

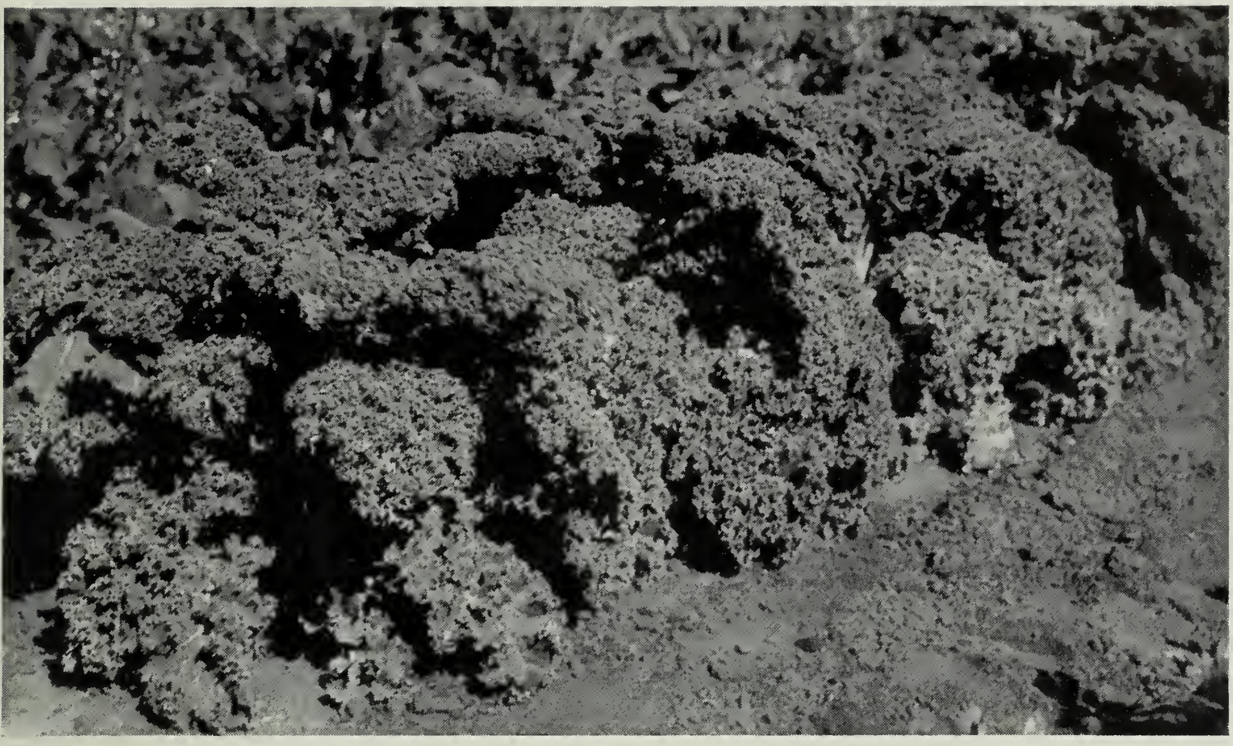


Fig. 14. The curled leaves of kale are useful to add to the attractiveness of a vegetable-collection display.

EGGPLANT

The standard entry is 2 specimens. These may be wiped but not washed. The specimens should be well-matched, dark-purple in colour, large to medium in size, solid, and free from bronzing.

Score Card for Eggplant

Uniformity and type	25
Condition (including freedom from blemish)	25
Colour of surface	25
Solidity of fruit	25

ENDIVE

The standard entry is 2 specimens. These should be well-matched, stout, crisp, tender, the hearts well-blanched, and the leaves of good shape, size, amount, and colour. The roots should be removed.

Score Card for Endive

Uniformity and type	25
Condition (including freedom from blemish)	20
Form of leaf	20
Colour of leaf	20
Size of plant	15

KALE

The standard entry is 2 specimens. The specimens should be well-matched, with foliage that is heavy, large, dark-green, closely set, and well-curled.

Kale is a useful type to add to the attractiveness of a collection display. Decorative effect is obtained by placing the kale between the various vegetables and around the edges of the collection.

KOHLRABI

The standard entry is 2 specimens. The roots should be removed just below the ball, that is, the stem pared off just below the swelling, and 4 to 6 leaves should be allowed to remain. The specimens should be tied neatly in bunched classes.

Score Card for Kohlrabi

Uniformity and type	25
Condition (including freedom from blemish)	20
Tenderness	20
Size	20
Colour	15

The specimens should be well-matched, of medium size (3½ to 4 inches diameter), good shape, and colour, with flesh that is crisp, tender, and solid, and a sweet flavour.

LEEK

The standard entry is 5 specimens. These should be well-matched, long, thick, firm, and tender, and with pure white, well-blanched stems. The tops should be shortened, the roots removed, and the entry neatly tied in bunches.

Score Card for Leek

Uniformity and type	25
Condition (including freedom from blemish)	25
Size of stems	20
Colour of stems	20
Tenderness	10

LETTUCE

The standard entry is 3 specimens. There should be separate classes for the various types that are likely to be entered.

Crisphead and Butterhead Types

The specimens should be well-matched, typical of the variety, with heads that are medium to large, firm, heavy, well-shaped, tender, crisp, fresh, compact, and of good flavour. The heads should be well trimmed by cutting off the butt close to the point of attachment of the outer leaves and removing the damaged and coarse outer leaves. The heads may be washed.

Cos Type

The heads should be conic or loaf-shaped, medium to large, with a blunt top, fairly firm or compact, well-blanched, and crisp, firm heart. The leaves should be fresh, of good conformity and there should not be any discoloured or injured outer leaves or flower stems.

Score Card for Head Lettuce

Condition (including freedom from blemish)	25
Solidity of head	20
Uniformity and type	15
Colour of outer leaves	10
Conformity of outer leaves	10
Size of head	10
Texture	10

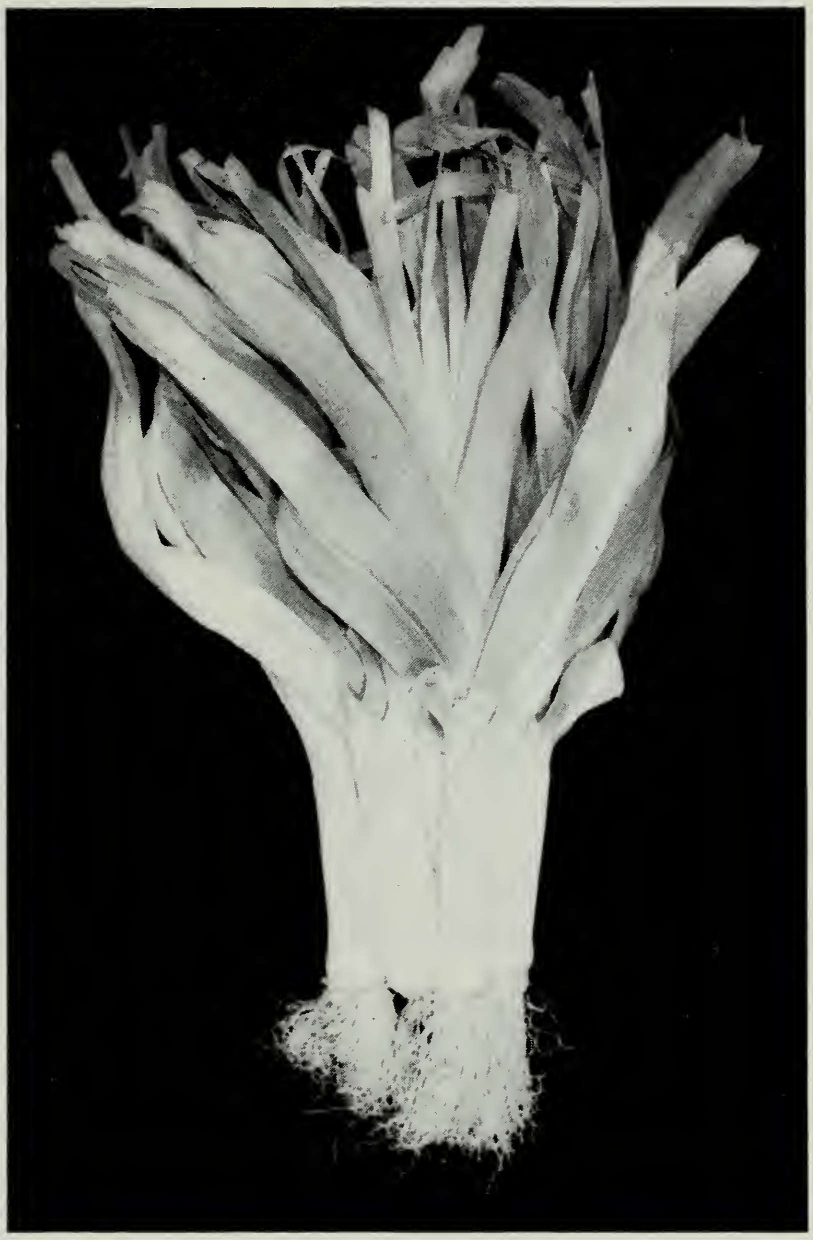


Fig. 15. Leeks.

Leaf Type

The specimens should be well-matched, typical of the variety, crisp, tender, reasonably compact, of good texture, well wrinkled, medium green, and free of excess bitterness. The entire plant should be cut just above the crown, and discoloured or injured leaves removed. The specimens should be washed thoroughly, being careful to avoid damaging the leaves.

Score Card for Leaf Lettuce

Condition (including freedom from blemish)	25
Texture	20
Uniformity and type	15
Colour	15
Size of plant	15
Habit of plant	10

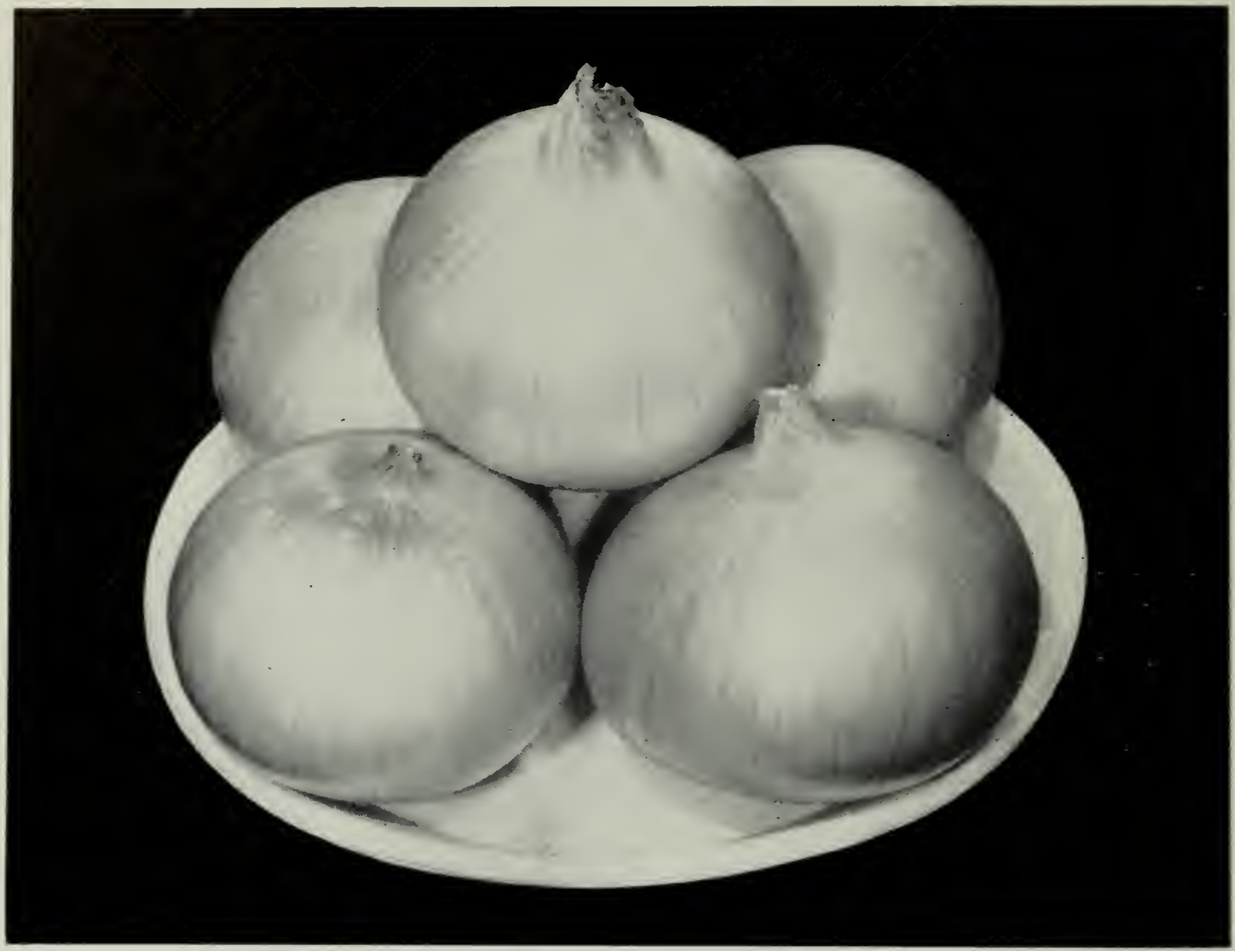


Fig. 16. Onion entry. (Simcoe Fair.)

MUSKMELON (Cantaloupe)

The standard entry is 2 specimens. These should be well-matched, mature-ripe, free of blemish spots, typical size for the variety, and with even ribbing and netting. The flesh should be thick, tender, of sweet flavour and good colour (pink or salmon usually preferred to green).

Score Card for Muskmelon

Flavour and texture	25
Uniformity and type	20
Condition (including freedom from blemish)	20
Flesh thickness	15
Netting and colour	10
Size of fruit	10

ONION

There should be separate classes for mature bulbs, pickling onions, and green-bunch onions. Mature-bulb classes should be divided at least into yellow, red, and white.

Mature Bulbs

The standard entry is 5 bulbs. The roots should be removed just below the base of the bulb; only jagged and dirty outer scales should be removed; the tops should be cut off ½ to 1 inch above the bulb.

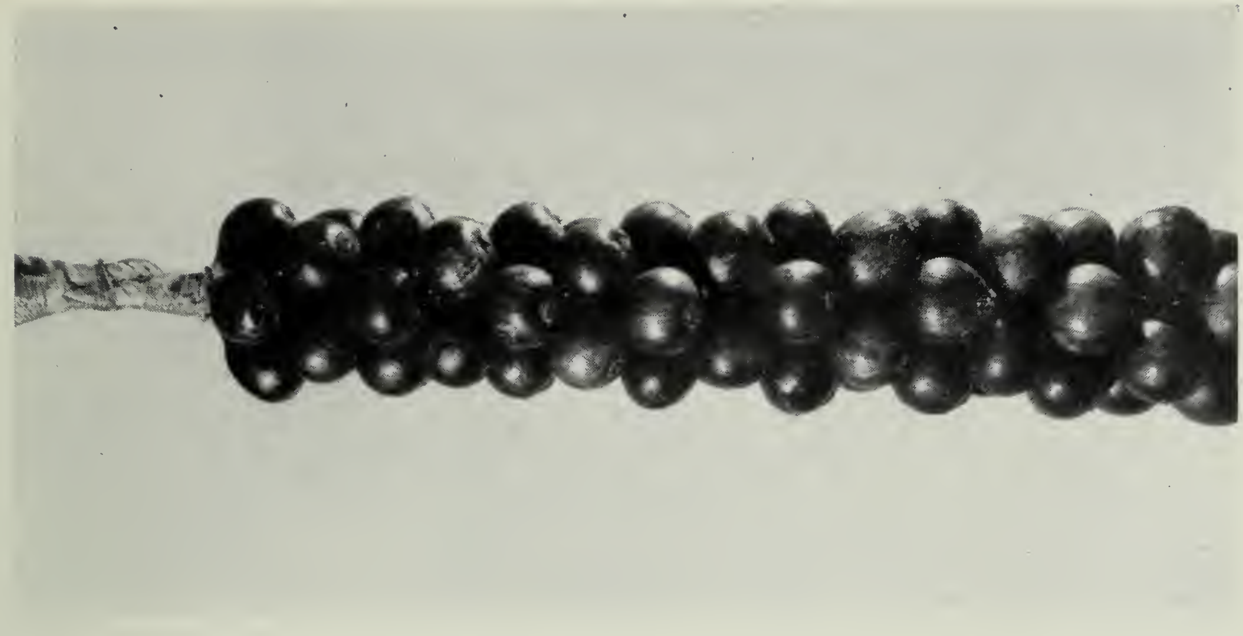


Fig. 17. A "rope" of onions. (Canadian National Exhibition.)

The specimens should be well-matched, typical of the variety but not less than 1¾ inches in diameter, well ripened with a small neck and bright, clean, dry outer scales. The specimens should be free from sprouts, doubles, and excessive sprouting. Though coarseness is to be avoided, heavy bulbs, other conditions being equal, receive preference.

Score Card for Mature-Onion Bulbs

Uniformity and type	25
Condition (including freedom from blemish)	20
Maturity	20
Exterior appearance	20
Size of bulb	15

Pickling Onions

The standard entry is 24 specimens. These should be well-matched, preferably white, firm, well cured, skin clear, bright, and clean. The specimens should be free from doubles, scallions, sprouts, and ovoid onions (length of axis exceeds diameter by over ¼ inch).

A diameter of ½ to ¾ inch is preferred but, according to the Ontario Farm Products Grades and Sales Act, 1951, the grade, for Canada No. 1 Pickling is, in part, "the onions in every package of this grade shall be at least 25 per cent by weight larger than 1 inch in diameter and not more than 3 per cent by weight shall be larger than 1¼ inches in diameter".

Green-Bunch Onions

The standard entry is 12 onions. These should be well-matched, clean, and with the loose skin removed. The tops trimmed to an even length.

PARSLEY

The standard entry is 2 specimens, and these should be shown in separate receptacles. The specimens should be well-matched and fresh. The plants should be large. The leaves should be young, crisp, healthy, dark-green, and well-curled.

Score Card for Parsley

Uniformity and type	25
Condition (including freedom from blemish)	25
Curl of leaf	25
Colour of leaf	15
Size of plant	10

PARSNIPS

Parsnips should be dug carefully and the dirt should be soaked off with water to avoid rubbing the skin (storage crops should not be washed). The small rootlets are trimmed off neatly. The standard entry is 5 roots.

Score Card for Parsnips

Uniformity and type	25
Condition (including freedom from blemish)	20
Smoothness	15
Colour	10
Crown	10
Freedom from side roots	10
Size	10

The specimens should be well-matched, firm, typical of the variety, of good size (not less than 2 inches diameter at crown but preferably not less than 3 inches unless the show is an early one), with long, even taper, and free of side roots. The skin should be clean, smooth, white, and free of discolouration. The crown should be uniformly and well-hollowed and the core small. The tops should be shortened to ½ inch above the crown.

PEAS

The standard entry is 12 pods, or 1 quart of shelled peas. The pods should be picked carefully and subsequently be handled as little as possible so as to avoid spoiling the bloom.

Score Card for Peas in the Pod

Uniformity and type	25
Condition (including freedom from blemish)	25
Filling of pods	20
Colour of pods	10
Even maturity of pods	10
Flavour	10

The specimens should be well-matched, typical of the variety, fresh, well grown but not over-mature, deep green in colour, with "bloom", and closely filled with peas which are tender, of good size, uniform, and sweet. Other conditions being equal, a long pod is considered superior to a shorter one.

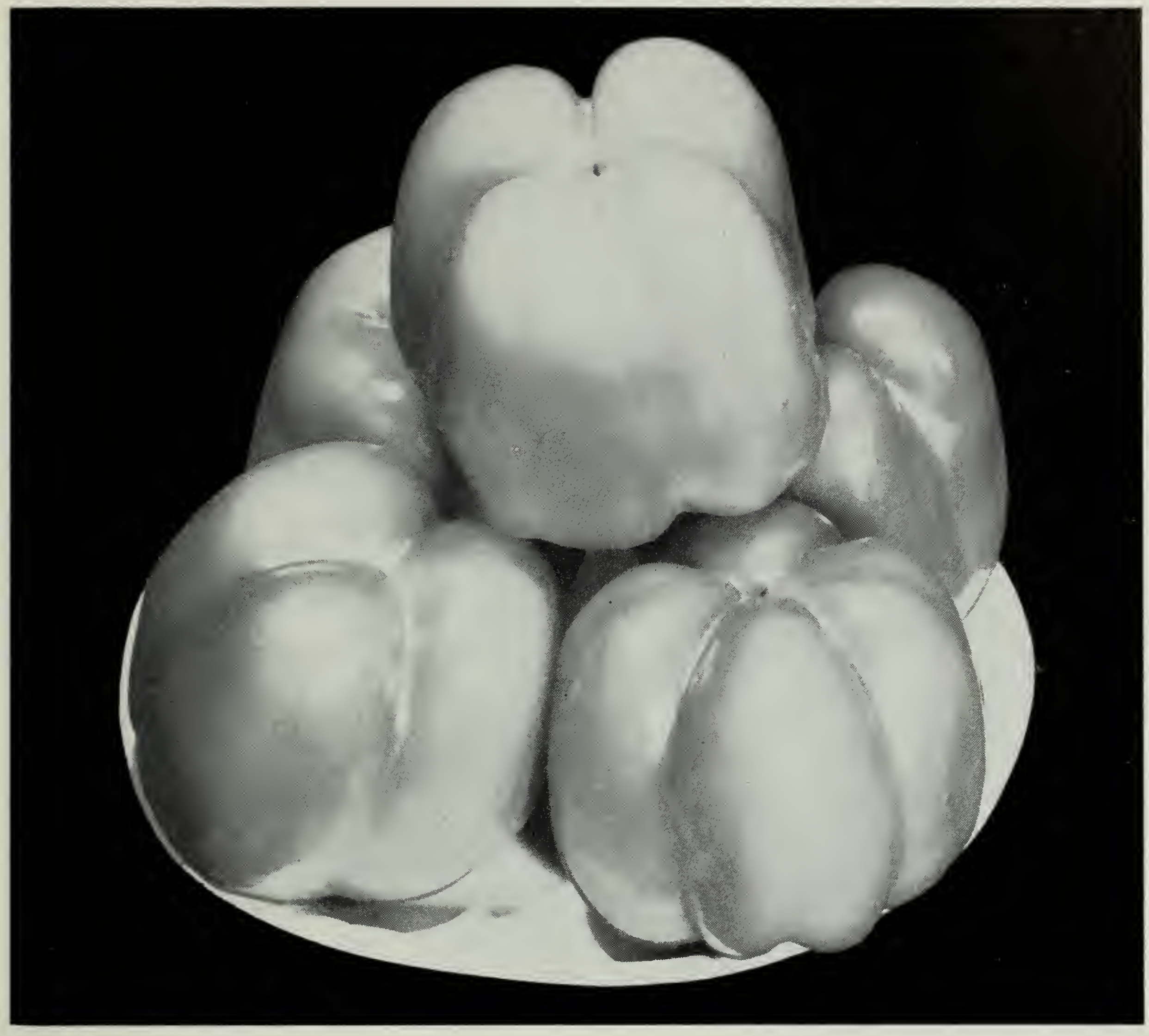


Fig. 18. A plate of sweet peppers. (Simcoe Fair.)

PEPPERS

The standard entry is 5 specimens. Separate classes should be provided for pungent or "hot peppers" and for mild or "sweet peppers". The prize list should state whether specimens are to be red, yellow, or green.

Score Card for Peppers

Uniformity and type	25
Condition (including freedom from blemish)	25
Thickness of flesh	25
Colour	25

The specimens should be well-matched, typical of the variety, heavy (thick flesh), with a smooth surface, and uniform in colour.

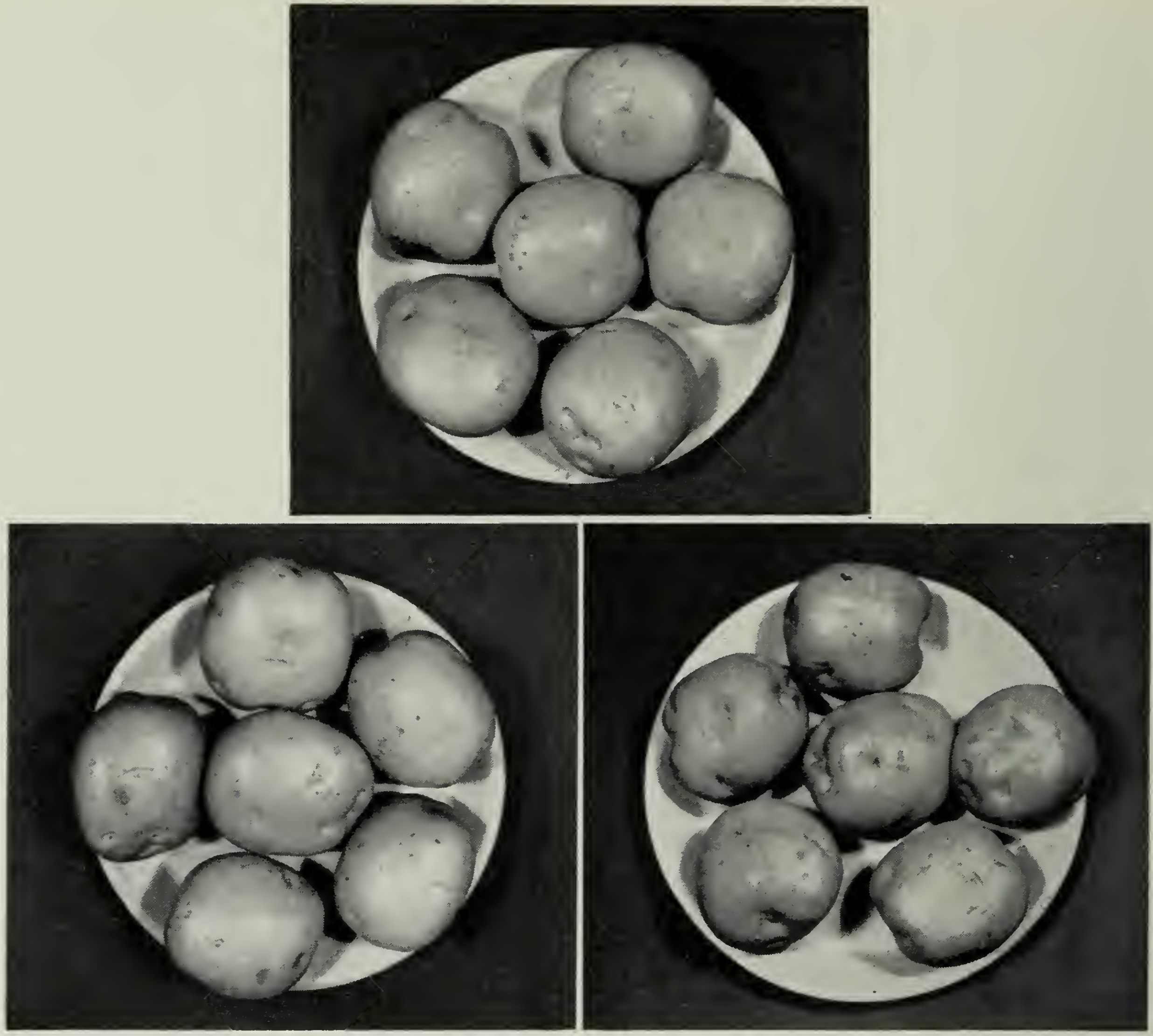


Fig. 19. Plates of potatoes. Top: Katahdin (seed). Centre: Katahdin (table). Bottom: Irish Cobbler (table).

POTATOES*

Potatoes should not be washed for show because washing causes the natural colour to fade somewhat. They should be brushed lightly to remove soil. Each entry should consist of 5 tubers, unless otherwise stated in the prize list.

Score Card for Seed Potatoes

General appearance (clean, bright, freedom from injuries)	20
Uniformity	10
Purity of variety	20
Conformity to type	
Shape (correct for variety)	15
Size (desirable for seed purposes)	5
Colour (correct for variety)	10
Skin and eye characters correct for variety	10
Freedom from disease: scab, rhizoctonia, late blight	10

---

*—Much valuable information, including descriptions of tubers of varieties commonly grown in Canada, is presented by N. M. Parks, Division of Horticulture, Central Experimental Farm, Ottawa, in "How to Select and Prepare Potatoes for Exhibit".

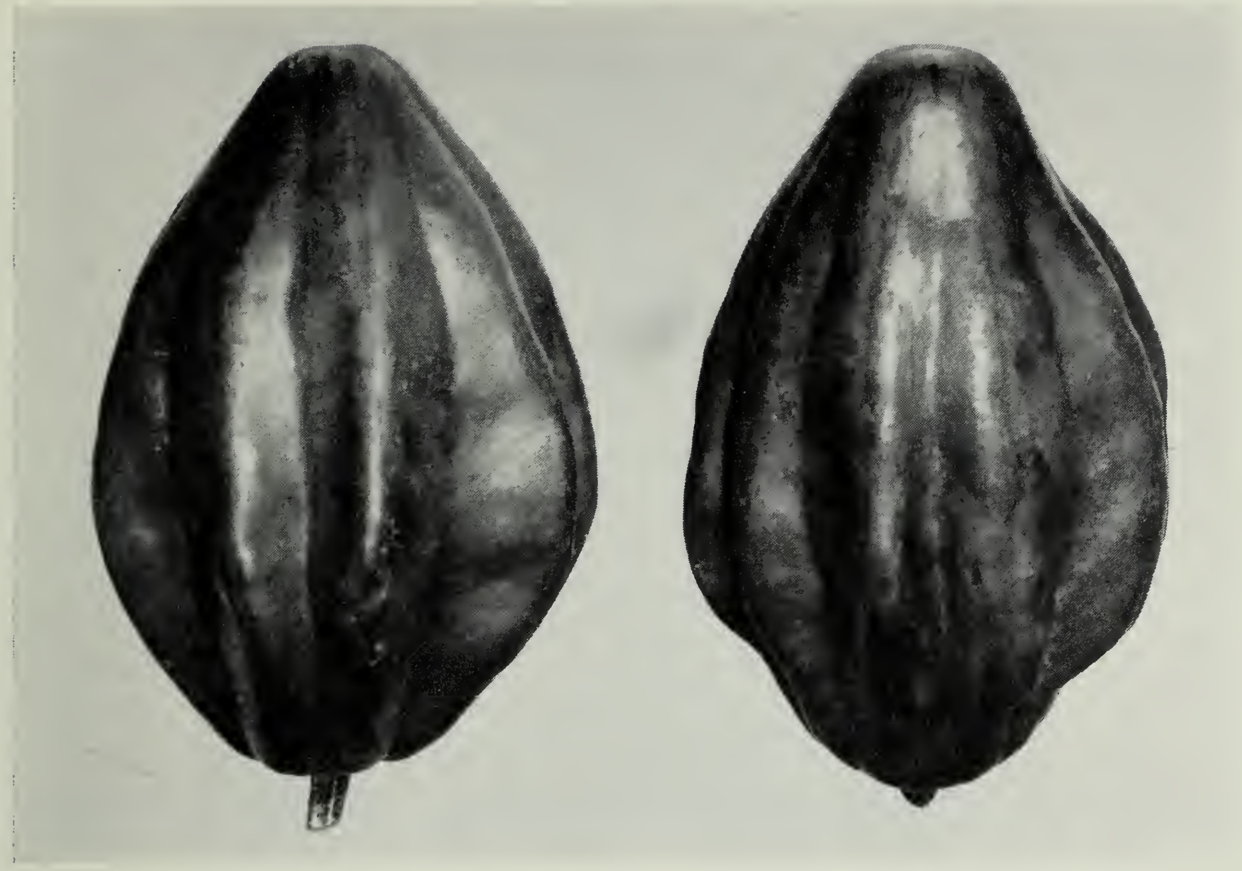


Fig. 20. Table Queen squash. (Galt Fair.)

Purity of variety	20
Maturity, quality, and texture of skin	10
Economy in peeling	
Freedom from visible disease, scab, rhizoctonia, blight, and silver scurf	20
Freedom from cuts, bruises, sunburn, insect injury	20
Varietal smoothness	10

Score Card for Table Stock Potatoes

General appearance (clean, bright, and attractive)	10
Uniformity and size	10

The specimens should be well-matched, typical of the variety, bright, clean, smooth, attractive in appearance (natural colour and bloom of skin retained), and not sunburned. The number of eyes and depth of eye varies according to variety but preferably should be few and shallow in table stock. The flesh should be firm, close-grained, and true in colour. Early potatoes necessarily may be immature, and the skin may peel. Late potatoes, because of the date of the show, may not always be mature but mature specimens may receive preference. Weight 6 to 12 ounces, according to variety, preferably 10 ounces.

According to the Ontario Farm Products Grades and Sales Act, 1951, the grade for Canada No. 1 potatoes is, in part, "at least 2 inches and not more than 4 inches in diameter and not less than 75 per cent by weight of the potatoes in any package 2¼ inches or more in diameter and in long-shaped varieties not less than 3½ inches in length and a minimum diameter of 1¾ inches."

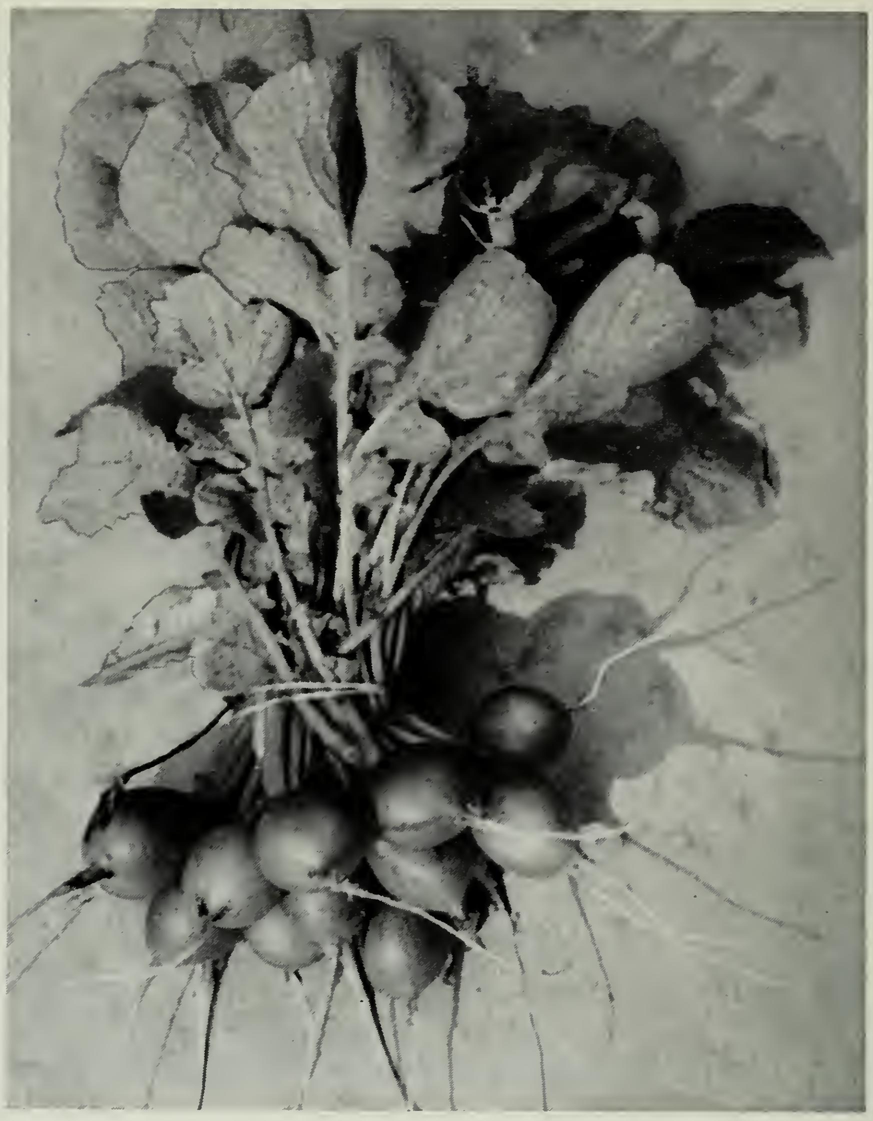


Fig. 21. Washing of radishes is permissible.

PUMPKIN AND SUMMER SQUASH

The standard entry is 2 specimens. These should be well-matched and typical of the variety. There may be a class for the largest specimen in the show. Though coarseness is always to be avoided, the heavier specimens, other characteristics being equal, receive preference. The stem should be left attached. The specimens may be washed.

Score Card for Pumpkin and Squash

Uniformity and type	25
Surface character	20
Condition (including freedom from blemish)	20
Size	15
Colour	10
Flesh	10

Pumpkins of the Pie group should be closely and clearly ribbed, smooth, heavy, free from any flat side, firm, good colour, preferably a uniform reddish-orange colour.

RADISH

Each entry should be tied in bunches of 6 to 10 radishes as specified. Different types, such as red and white radishes, should be in separate classes.

Score Card for Radish

Uniformity and type	35
Condition (including freedom from blemish)	30
Colour	15
Flesh	10
Size	10

The specimens should be well-matched, typical of the variety, and firm. They should be neatly bunched (tops and roots left on), washed or otherwise clean, of a smooth, even form, medium in size, tender, crisp, and of a clear, bright colour or colours.

RHUBARB

For show purposes, it is suggested that the number of stalks per entry be 3, 6, or 12. The required number should be stated in the prize list.

The specimens should be well-matched, fresh, and neatly tied. The stalks should be straight, well coloured with red, and smooth. The flesh should be crisp, tender, and of good flavour. In trimming, the leaves are cut back to prongs not exceeding one inch long and the bracts at the base of the stalk are removed. In harvesting, the tops should be pulled out, not cut.

Score Card for Rhubarb

Uniformity and type	25
Condition (including freedom from blemish)	20
Tenderness	20
Colour	15
Length of stalk	10
Thickness of stalk	10

According to the Ontario Farm Products Grades and Sales Act, 1951, the grade for No. 1 field rhubarb is, in part, "this grade shall consist of stalks at least one-third of red colour, at least ¾-inch in diameter and at least 2½ inches in circumference at or near the butt and they shall be at least 10 inches in length."

SPINACH

The standard entry is 2 plants. These should be well-matched, fresh, and with the plant cut just below the crown. The leaves should be dark-green, tender, large, broad, thick, and well savoyed or smooth, according to the variety. There should not be any seedstems. Washing is permissible.

Score Card for Spinach

Uniformity and type	20
Condition (including freedom from blemish)	20
Size of plant	20
Colour of leaf	15
Thickness of leaf	15
Surface of leaf	10

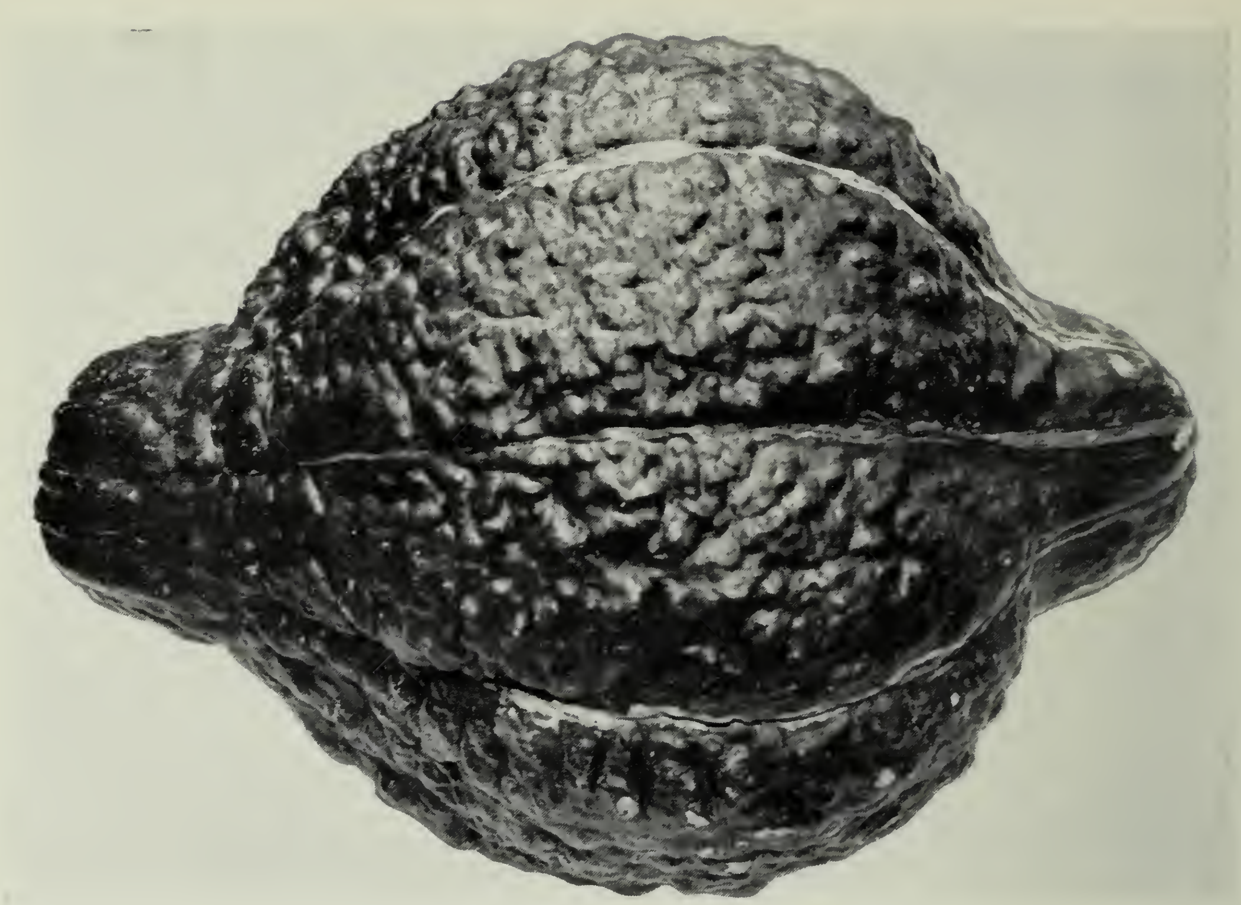


Fig. 22. Hubbard squash. (Galt Fair.)

SQUASH (Winter)

(For Summer Squash, see under Pumpkin)

The standard entry is 2 specimens, although in comparatively small shows one specimen is acceptable. For Score Card, see Pumpkin.

The specimens should be well-matched, typical of the variety, medium to large, thick-fleshed, heavy in proportion to size, and with a short stem. Warted varieties should be well and evenly warted (warted types of Hubbard are preferred to the smooth strains). The rind of all varieties should be very hard when mature, though in some it will naturally be thinner than in others. The specimens should not be washed, as this is a storage type. There should be a minimum of light colour on the under side.

TOMATO

The standard entry is 6 specimens. Ripe, but not soft. The prize list should state whether or not the calyx should be present on the fruit.

Score Card for Tomatoes

Uniformity and type	25
Condition (including freedom from blemish)	25
Even ripening	20
Flesh colour	15
Flesh solidity	15

The specimens should be well-matched, firm, typical of the variety, sound, free of cracks and large blossom scars, smooth, clean, bright, well and evenly coloured, and the flesh uniform throughout. In tomatoes,

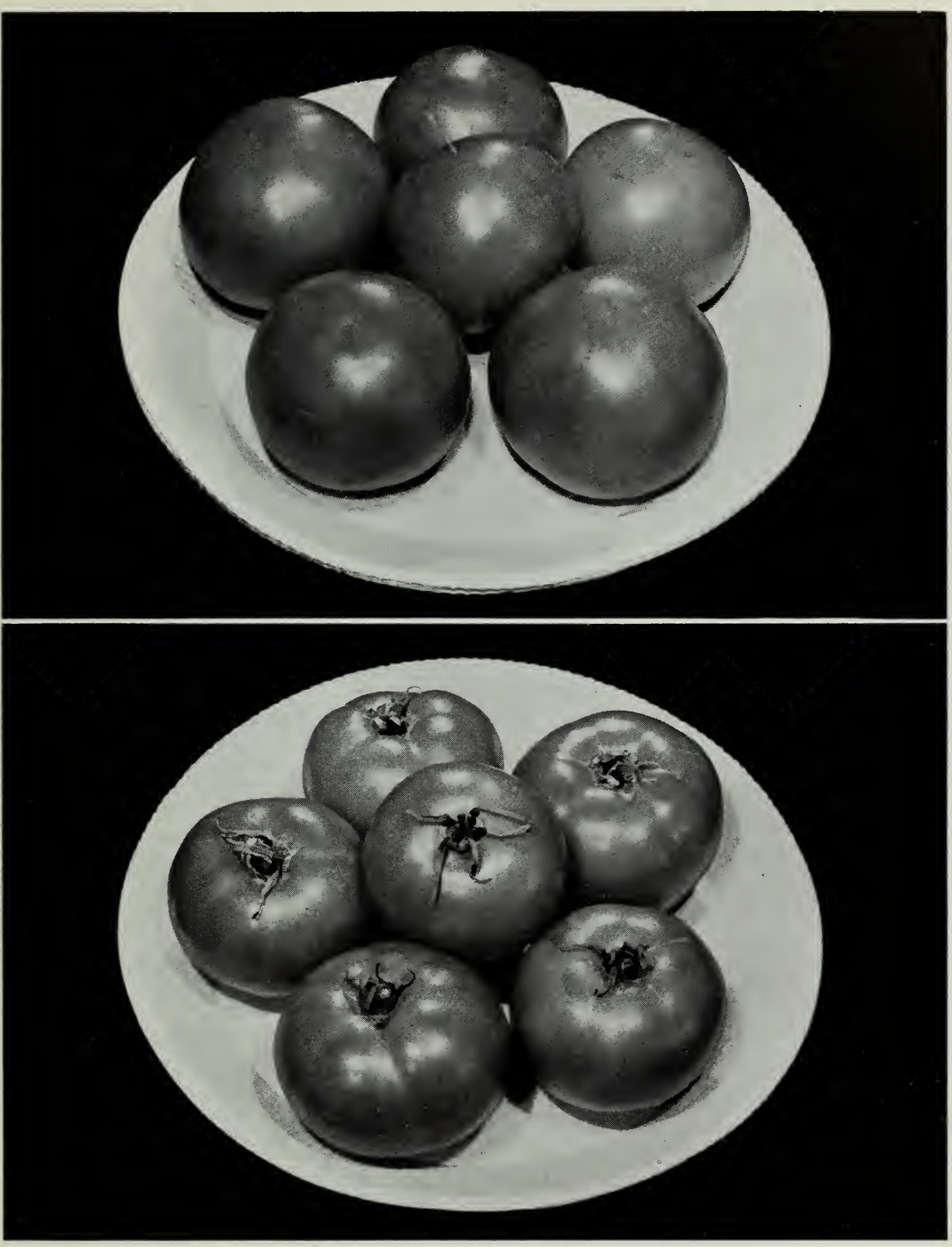


Fig. 23. Two views of a tomato entry. (Simcoe Fair.)

"Select" is a higher grade than "No. 1". According to the Ontario Farm Products Grades and Sales Act, 1951, the size for Select Grade is, "of a minimum size of $2\frac{1}{4}$ inches and a maximum size of $2\frac{1}{2}$ inches in diameter or a minimum size of $1\frac{3}{4}$ inches and a maximum size of $2\frac{1}{4}$ inches in diameter or a minimum size of $1\frac{1}{2}$ inches and a maximum size of $1\frac{3}{4}$ inches in diameter".

Fig .24. A collection of a wide range of vegetables of high quality. (Brampton Fair.)

SWEDE TURNIP (Rutabaga)

The standard entry is 3 specimens. The prize list should mention the number of specimens required. There should be separate classes for Swede turnips and true or soft turnips.

Swede turnip specimens should be well-matched, typical of the variety, 3½ to 5 inches diameter (larger specimens tend to be feed stock rather than table stock) ; smooth, shapely, and with a clear skin. The flesh should be crisp, tender, and free from water core. The tops and roots should be trimmed off without leaving large scars. When bunched, the specimens should be succulent, about half grown, and with the tops attached. Storage specimens should not be washed.

Score Card for Swede Turnip

Uniformity and type	25
Smoothness and shape	25
Condition (including freedom from blemish)	25
Colour of surface and flesh	15
Trimming	10

VEGETABLE MARROW

The standard entry is 2 specimens. These should be well-matched, typical of the variety, cylindrical, smooth, firm, slightly ribbed, not over-mature, and with short stem attached. For jam purposes, large size is preferable; for culinary purposes, medium size.

Score Card for Vegetable Marrow
(culinary purposes)

Tenderness	40
Size and form	30
Uniformity	30

Score Card for Vegetable Marrow
(for jam)

Size and form	60
Ripeness	40

VEGETABLE COLLECTIONS

A collection consists of an assemblage of a number of kinds and varieties of vegetables in one exhibit. The number of specimens of each kind and of each variety should be clearly stated in the prize list. Collections are commonly placed in a specified area of space.

The question is often raised as to whether the following kinds are fruits or vegetables. Simply and briefly, rhubarb, fruits of the vine family (cucumber, muskmelon, watermelon, citron, pumpkin, and squash), tomato, pepper, and eggplant are eligible for vegetable collections.

Score Card for Vegetable Collections

Quality, value, and condition	30
Shape, size, and colour	20
Arrangement	20
Variety of kinds and varieties	15
Uniformity	10
Labelling	5

WATERMELON

The standard entry is 2 specimens. These should be well-matched, typical of the variety, medium to large, heavy, firm, smooth, mature, sweet, flesh thick. A deep red flesh colour is preferred to cream and other light colours. The white spot where the fruit rests on the ground should have changed to a yellowish tinge.

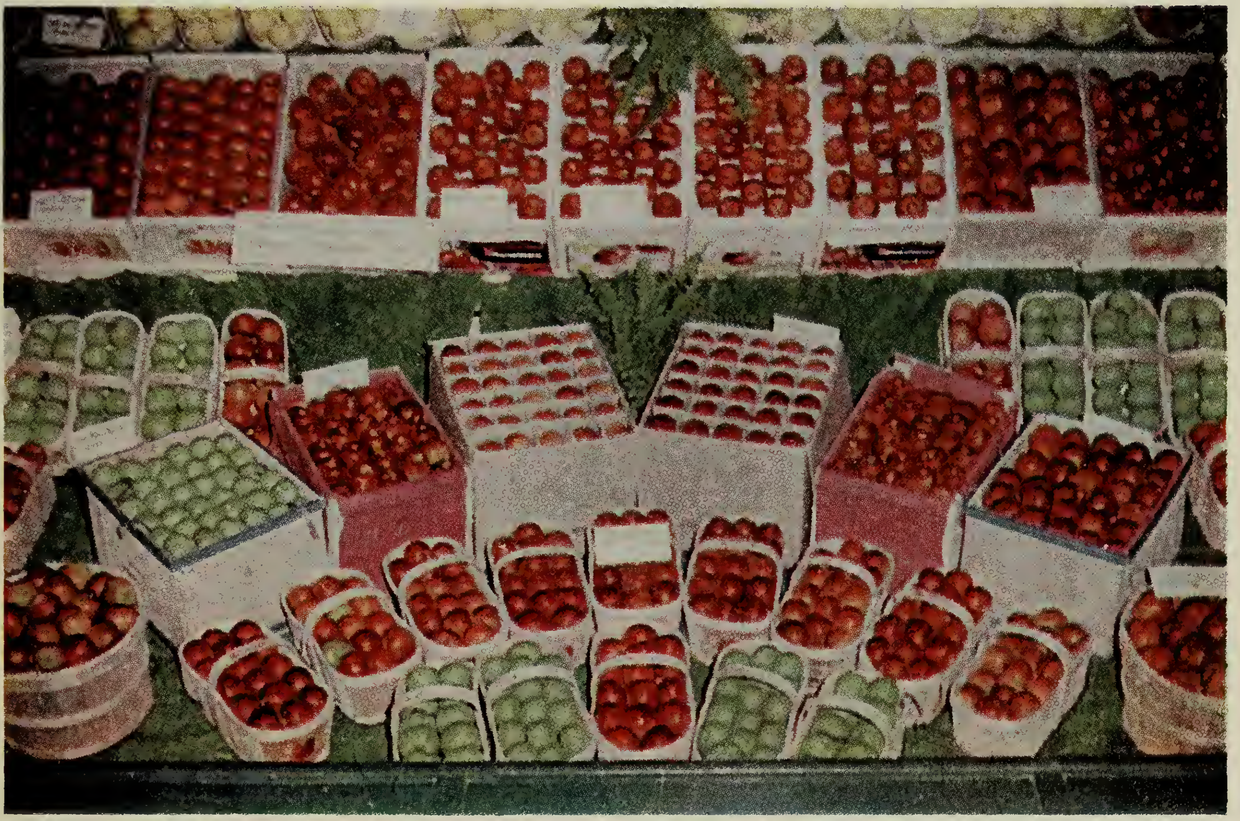
Score Card for Watermelon

Flavour and texture	25
Uniformity and type	20
Size of fruit	20
Condition (including freedom from blemish)	20
Flesh thickness	15

BULLETIN No. 489 APRIL, 1952

EXHIBITING AND JUDGING FRUIT

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

Page
INTRODUCTION 3
ASSEMBLING FRUIT FOR EXHIBIT 3
RULES AND REGULATIONS 4
  Prize Lists 4
  Labelling 6
ARRANGING THE EXHIBIT 6
  Background 6
  Display Tables 6
  Display Receptacles 7
JUDGING THE FRUIT 9
  Apples 9
  Crabapples 12
  Cherries 12
  Grapes 13
  Peaches 14
  Apricots 15
  Pears 15
  Plums 17
  Quinces 17
  Any Other Variety Class 17
  Small Fruits 18
  Fruit Collection 19
  Fruit Display 20
  Preserved Fruit 20

EXHIBITING AND JUDGING FRUIT

by

B. J. E. Teskey and J. S. Shoemaker

Department of Horticulture, Ontario Agricultural College, Guelph, Ontario.

INTRODUCTION

Many horticultural shows are held annually throughout the province. These shows may be sponsored by fall fairs, horticultural societies, service clubs, or other interested groups. They range in size from small shows of local interest to large exhibitions of a provincial or national interest and influence. Fruit exhibits are an important and colourful part of many horticultural shows.

A horticultural exhibition exerts a beneficial influence on horticulture in several ways. It creates competition among growers and this helps to stimulate greater interest in producing top-quality produce. It has a definite educational value, making both the growers and the general public quality conscious, and acquainting the consumer with popular kinds and varieties of fruits. It promotes pride in the produce grown in a district. It is also an advertisement for the products of the grower and the community.

Fruit exhibitors may be classified as commercial growers or home gardeners. The former grows fruit on a large scale for profit, and is thus interested in quality from the standpoint of the commercial market. The home gardener, on the other hand, is not interested in market preferences since he does not sell the produce of his garden. He is interested in quality only as it is expressed in appearance, flavour, and palatability. He grows fruit chiefly as a hobby. The home gardener is often referred to as an "amateur".

Although there are these two points of view, there can be no distinction made between them in the judging of the entries unless the prize list definitely specifies a class as being "commercial". Both the commercial grower and the home gardener or amateur should aim at exhibiting the ideal specimen.

The emphasis in this bulletin is placed on suggestions for shows of small to medium size. However, the principles set forth will apply in most cases to shows of any size.

ASSEMBLING FRUIT FOR EXHIBIT

To be able to display prize-winning fruit the grower must first carry out the best cultural practices. Proper soil management, pruning, thinning, and spraying are essential. Thinning of the fruit is of special importance in promoting proper size and colour. The best fruit is often near the top of the tree. Fruit for exhibition should be picked when firm-ripe and if it is necessary to hold it for any length of time it should be kept in cold storage. It should be handled with the greatest of care to avoid bruising and punctures. Usually ten or twelve times as much fruit as will be used in the exhibit should be harvested in order to provide a sufficiently wide choice in making the final selection.

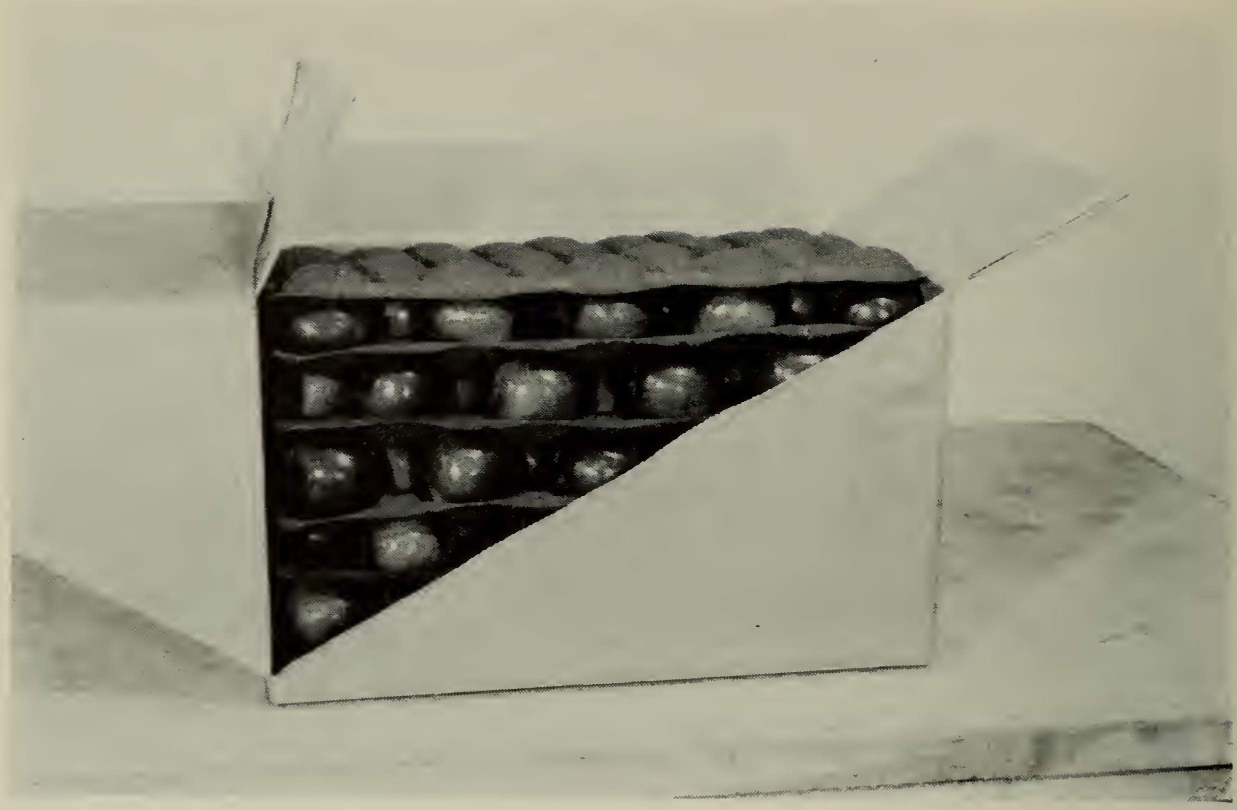


Fig. 1—Packing the fruit in corrugated egg-cell cartons is an effective method of maintaining prime condition.

The points which the exhibitor should keep in mind when selecting specimens for his exhibit are the same as those which the judge will use in his placing of the entries. See later under "Judging".

Apples and pears which are to be held for some time before the show, or which must be shipped or trucked, might wisely be individually wrapped in glazed paper. Wrapped fruit packs easily and is protected from decay and injury. The use of shredded paper and corrugated egg-cell boxes is also quite effective in maintaining prime condition.

RULES AND REGULATIONS

The rules and regulations under which horticultural shows are held vary with many circumstances, including the size of the show, range of products exhibited, and value of the awards. They should be complete enough, however, to guide all concerned in its conduct. They should be clearly stated, and they should be prominently printed with the schedule or prize list of the organization holding the show. The judge should be guided by the rules and regulations of the show in all matters of policy. His decisions with regard to the placings of the entries should be considered as final. A clerk should be provided to assist the judge. All exhibitors should be excluded from the exhibition room while the judge is making his placements.

Prize Lists

The success of an exhibition is greatly dependent upon the preparation of a clear, accurate catalogue of well-selected classes. The vagueness and ambiguity of many prize lists lead to misunderstandings and to unwise compromises and concessions. The schedule should clearly indicate (a) the

Fig. 2—The exhibition room should be cleared of exhibitors and spectators while the judging is in progress.

kind and variety of fruit, (b) the number of kinds or varieties if a collection, (c) the number or quantity of specimens for each entry, (d) the display receptacles to be used, (e) the time when exhibits must be ready for judging, and (f) other particulars that are necessary for the guidance of exhibitors and judges.

The listings must be accurate, carefully selected, and should include only kinds and varieties that possess horticultural standing in the region. They should not include varieties that will be over-ripe, for example Shiro plums in November, or those which will be very immature at the time of the show, for example Northern Spy in August. There is no objection to prolonging the life of mature fruit by cold storage, and where this is possible it permits of more comprehensive prize lists.

The following is suggested as examples of classes for a fruit prize list:

Class 30 — Apples

Section 1. Five McIntosh Red
2. Five Wealthy
3. Five Rhode Island Greening
4. Five any other fall culinary variety, named
5. Five any other fall dessert variety, named
6. One half-bushel hamper Wealthy, properly packed with liner
7. Box Cortland, approximately 1 bushel, flat pack with liner
8. Three six quart baskets McIntosh, packed

Class 31 — Pears

9. Five Bartlett
10. Five Anjou
11. Five Flemish Beauty
12. Five any other variety, named
13. Six-quart basket Bartlett

Class 32 — Peaches

14. Five Golden Jubilee
15. Five any other variety, named
16. Three 6-quart baskets, any variety, named, properly packed with collars and plastic covers

Class 33 — Grapes and Plums

17. One plate green (mature) plums, named
18. One plate blue or purple plums, named
19. Three bunches blue grapes, named
20. Three bunches red grapes, named
21. Two 6-quart baskets blue grapes, named, and properly packed

Class 34 — Collections

22. Collection of pear varieties, 5 specimens of each variety, named
23. Collection of raw fruit to occupy 12 square feet, choice of kinds and varieties, loose or in standard containers

Class 35 — Special Commercial Class

Containers must be properly stamped and fruit properly graded and packed to conform with government regulations.

24. Five 6-quart baskets Wealthy apples
25. Five 6-quart baskets McIntosh Red apples
26. Five 6-quart baskets R.I. Greening apples
27. Five 6-quart baskets Golden Jubilee peaches

Labelling

A label, which indicates clearly the class, section, variety, exhibitor's number, etc., should accompany each entry. A fruit exhibit in which variety names are not shown lacks greatly in educational value. The committee in charge should furnish uniform, neat labels together with pins or other device for attaching them to the entries. All labels should be attached in a uniform manner.

ARRANGING THE EXHIBIT

It is important that the exhibition room be well lighted. Good lighting assists the judges and improves the appearance of an exhibit.

Background

All decorations and background should be subordinate in colour and design to the fruit which is the major attraction in the exhibit. A background of a solid neutral colour such as white or green is very good because it sets off the fruit well without competing with it for attention. Shades of green are particularly desirable for red fruit. Burlap in dark tan may be used to advantage with yellow, green, or red fruit.

Display Tables

Display tables which are long and not more than 4 to 6 feet wide are better than those which are so wide that it is difficult to reach the centre. Along the walls, fruits may be banked with leaning trays. This may require special racks but proper viewing is not possible when fruit is placed on shelves at different levels.

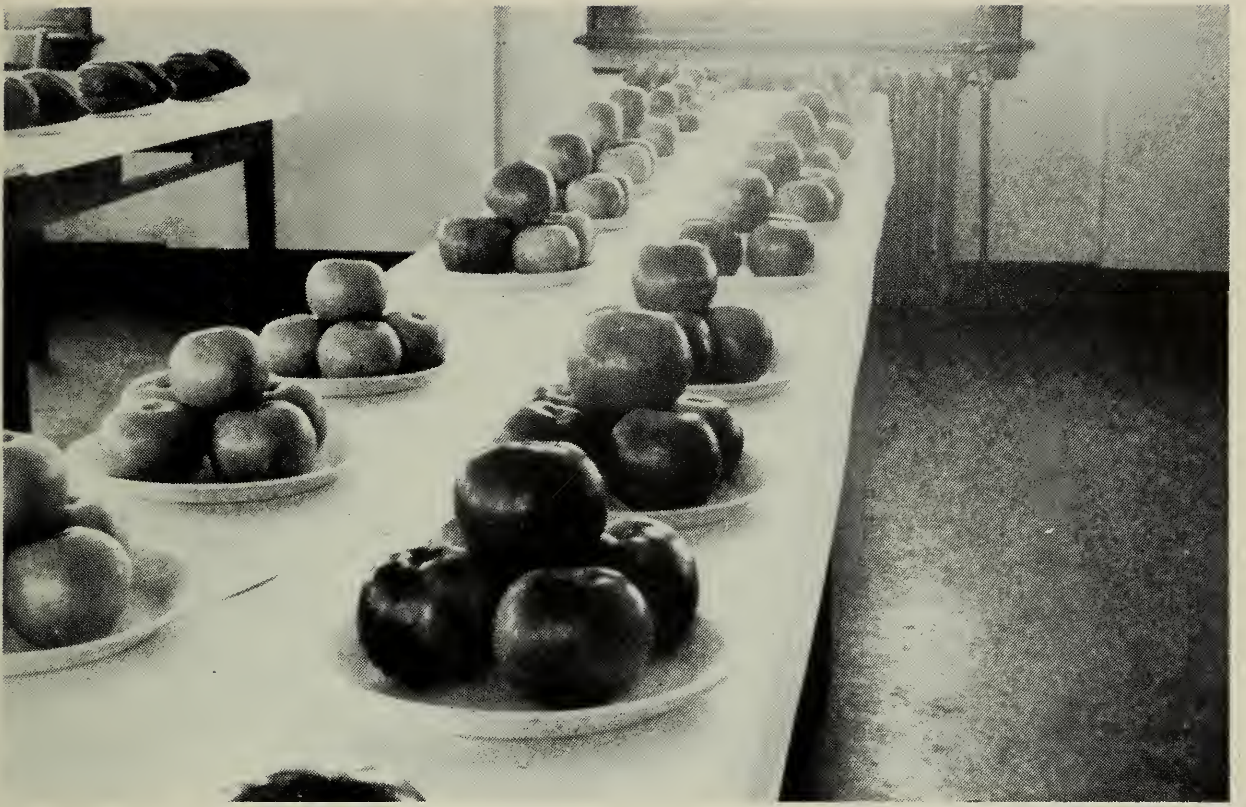


Fig. 3—A long narrow display table is well suited to the exhibiting of fruit.

Display Receptacles

It is highly desirable that the entries be displayed on trays, plates, or other containers which are uniform in size, shape, and colour, and which show the fruit to the best advantage. When fruit is displayed in inappropriate receptacles or when uniformity is lacking, the exhibit fails to arouse proper interest. It is customary for the committee in charge to supply plates and trays. Other containers are provided by the exhibitors. Baskets and boxes should be new and clean.

Identifying marks should not appear on the containers except in special commercial classes. In this case the boxes and baskets should be properly stamped to conform with government regulations set forth in the Farm Products Grades and Sales Act.

Standard 8-inch rough, rolled-edge paper plates are commonly used and are especially appropriate for the small fruits and where the exhibitors are small growers or home gardeners. Other display units which may be used are trays, standard boxes, bushel baskets, and 6-quart baskets.

The standard system for arranging fruit on the plates is as follows: five apples placed stem up on the plate, or four on the plate and the fifth resting on the other four; five pears, peaches, or quinces, placed on their sides or the fifth can be placed on top of the others in the centre; with plums and cherries, as many fruits as necessary to complete one layer are placed on the plate. The stems of the outer ring may be neatly placed toward the centre of the plate. Three bunches of grapes make up a plate. The number of specimens per entry mentioned for each fruit in this bulletin is suggestive in a general way and may be modified to advantage according to the size of the show and other factors. The quantity or number required should be definitely stated in the prize list.

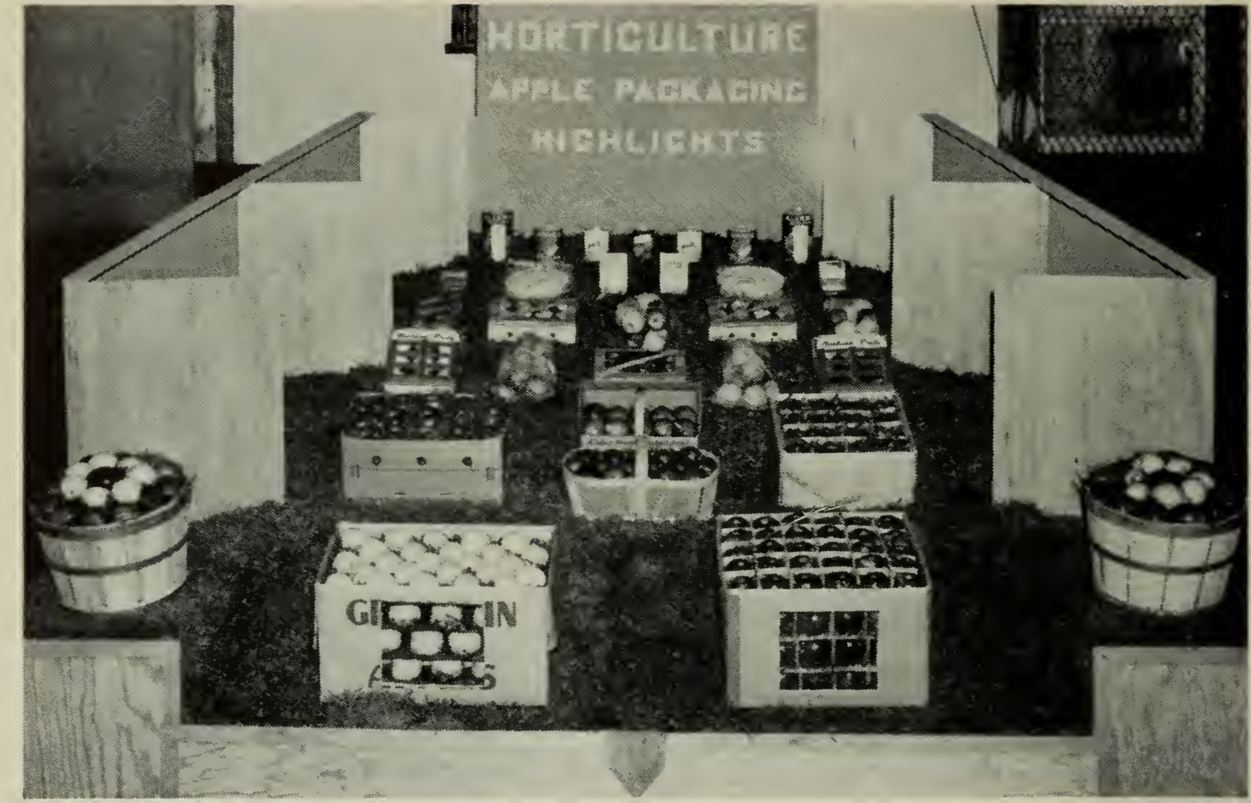


Fig. 4—The background in an exhibit should be subordinate in colour and design to the fruit which is the main attraction.

A label should accompany each entry but such labels should be attached in a uniform manner at the rear of the entry away from the observer. The grower's name, orchard, and address should be shown after judging has been completed. Such information is of interest to other growers and to the general public as well as having publicity value to the exhibitor.

Care should be taken in arranging the exhibits on the display table. All plates in the same class should be placed together in a definite arrangement. The entries should be aligned perfectly both across and lengthwise of the table. Crowding should be avoided. Each entry should show as a distinct unit against a plain background of white, green, or brown.

Polishing of apples and pears with a soft dry cloth gives the fruit a glossier finish but this practice is usually covered (for or against) in the rules governing the exhibit. Stems of apples may be clipped to avoid puncturing but otherwise must be intact.

Preserved Fruit

Many horticultural shows include a class for preserved fruit and vegetables. The inclusion of this class is of advantage to the show in a number of ways: (a) makes possible the exhibiting of some crops, for example, raspberries, cherries, peaches, etc., which may not be in season at the time the exhibition is held: (b) encourages greater participation by women and girls: (c) adds to the attractiveness and interest of the show; and (d) suggests to the general public a wider use for these crops.

Since preserved fruit at exhibitions is usually judged entirely on appearance, attractiveness of the pack is of prime importance. The preserved fruit is best shown in glass containers, and these should be uniform in size and type. The same basic principles mentioned for the arrangement of the fresh fruit also apply to the preserved product.

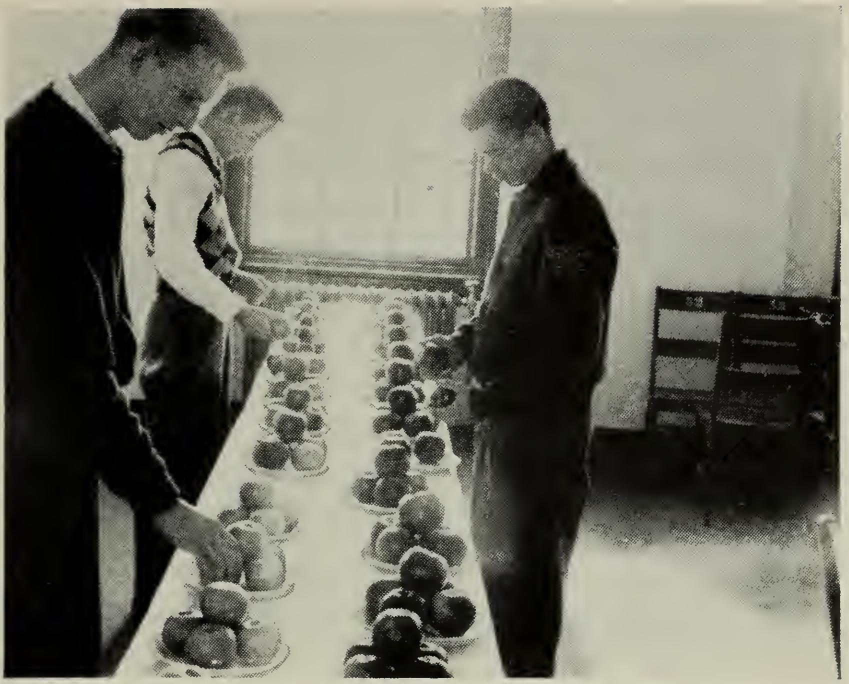


Fig. 5—In a judging competition the judges should handle the fruit carefully and not alter it in any way.

JUDGING THE FRUIT

Both the judge and the exhibitor should have in mind a picture of the ideal specimen. Awards should not be made to unworthy entries although they may be the only ones of their kind on exhibition. To give an entry of inferior quality first prize defeats the purpose of the show, even though the entry is the only one in the class.

When the class calls for a certain variety, a specimen of another variety mixed with it disqualifies the entry. Where a definite quantity or number of specimens per entry is required according to the prize list, one specimen more, or one less disqualifies the entry. In matters of this kind, the strict interpretation of the rules should be left to the discretion of the judge.

A score card is useful as a guide and to impress the relative importance of the different points. The exhibitor should be well acquainted with the points by which his exhibit will be judged. When a score card is used, points are deducted on a percentage basis. Otherwise too great a deduction will be made on the less important items on the score card and a too moderate deduction on the more important items.

In judging a class, some entries may often be eliminated immediately because it can be seen at a glance that they are outclassed or disqualified. In any class, the task of placing the entries is simplified if the class is first divided into two parts with the obvious losers in one group. The better group of entries would then be judged.

APPLES

Apples are produced in all the fruit-growing districts of Ontario. Because of this, and the fact that they store and handle well, apples are more commonly shown than any other fruit.

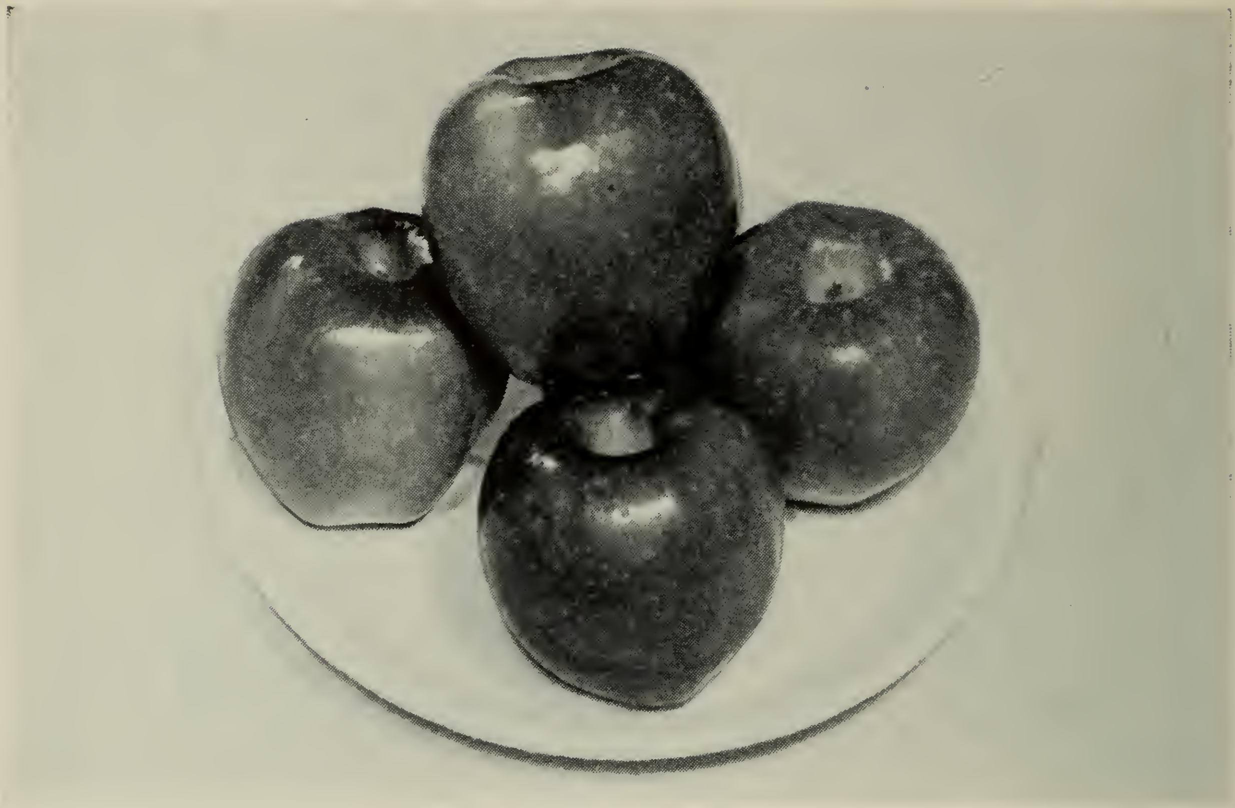


Fig. 6—When apples are shown on plates, five are placed, stem up; four on the plate and the fifth resting on the other four apples.

Score Card for Apples Shown on Plates

Condition	30
Colour	25
Size	20
Uniformity	15
Form	10

Condition

Good condition is of prime importance and heavy deductions should be made for any blemishes which detract from the grade or keeping quality of the fruit. The presence of codling moth or apple maggot disqualifies the entry. Scab, scale, physiological disease such as bitter pit, breaks in the skin, absence of stem, and shrivelling and bruises, are examples of major blemishes.

Uniformity

All individual specimens in an entry should be uniform in form, colour, and size. This is especially important because if uniformity is lacking, the entry receives a double cut. If, for example, the colour of one apple is off-type, the plate or entry is scored down under "colour" and again under "uniformity".

Colour

With red varieties, colour is the factor which makes the difference between "Extra-fancy" and "Fancy" or "Cee" grades. Red varieties, for example McIntosh, Spy, and Delicious, should be well coloured. The regular strain of a red variety is often at a disadvantage when shown in competition with a more highly coloured sport of that variety. On this point, preference is given the entry with the most attractive colour. With "uncoloured" varieties, such as Greening and Golden Delicious, a blush is considered unfavorable.

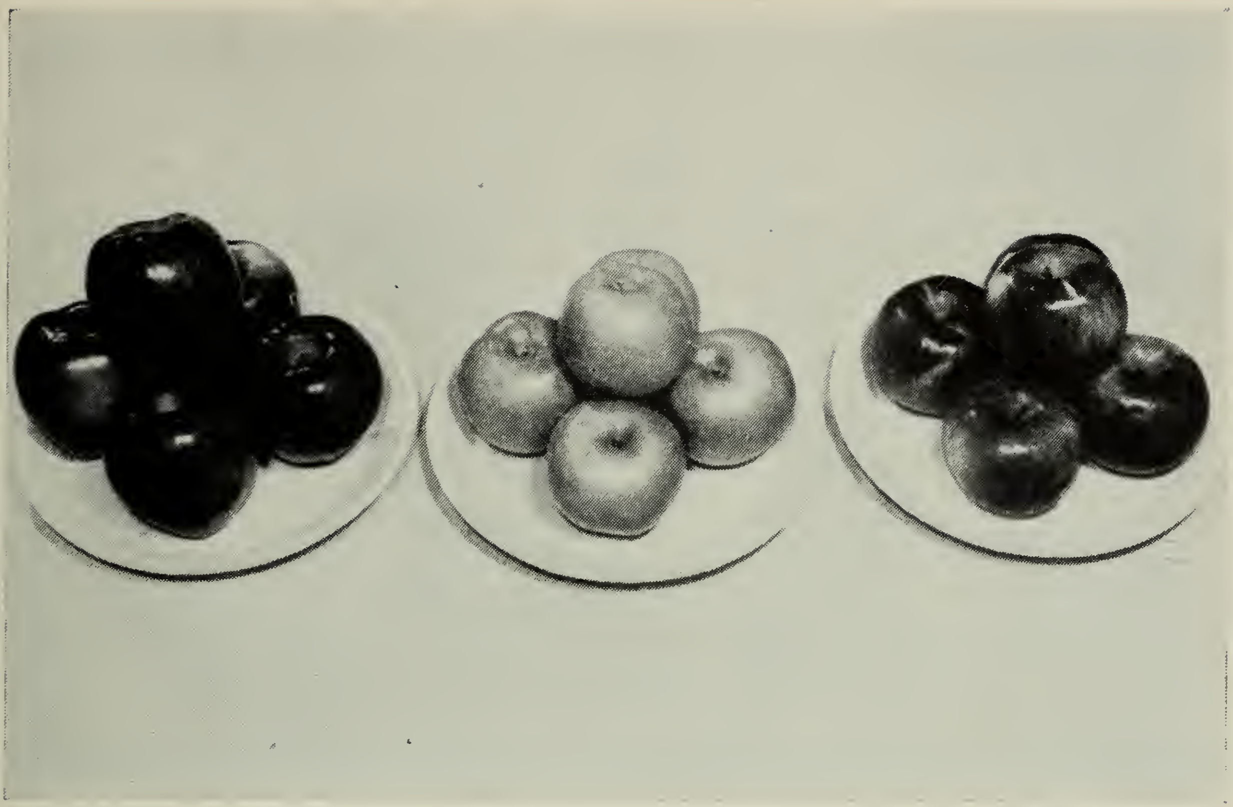


Fig. 7—Each specimen in an entry should be typical of the variety. LEFT: Delicious; MIDDLE: Rhode Island Greening; RIGHT: Cortland.

Size

Large size is not necessarily the criterion of a good apple. Overly large fruit is generally of inferior quality and is difficult to pack. The most acceptable commercial size for the variety should be considered as the ideal. The minimum size for most varieties as given in the Farm Products Grades and Sales Act, is 2¼ inches in diameter. The most preferable size for medium-size varieties like McIntosh is around 2¾ inches diameter. Varieties like Snow, Jonathan, and Melba are smaller, whereas Northern Spy is a little larger than McIntosh.

Form

Every variety possesses a characteristic shape or form. Delicious, for example, is conic with five usually distinct ribs, and five crowns on the shoulders at the blossom or calyx end. Cortland is oblate or somewhat flattened at the stem end, and is corrugated near the calyx. The form of each specimen should be typical of the variety.

When fruit is exhibited in boxes or baskets consideration must be given to the packing and to the packages. Points are awarded for neatness, firmness, and general attractiveness of the pack. The container should be new, clean, and attractive. The prize list should indicate the type of pack and, in the case of hampers, whether a liner or decorative collar is to be used.

Score Card for Apples and Pears in Boxes and Baskets

Packing	
Attractiveness and style	10
Compactness	10
Neatness of wrapping	5
Alignment	5

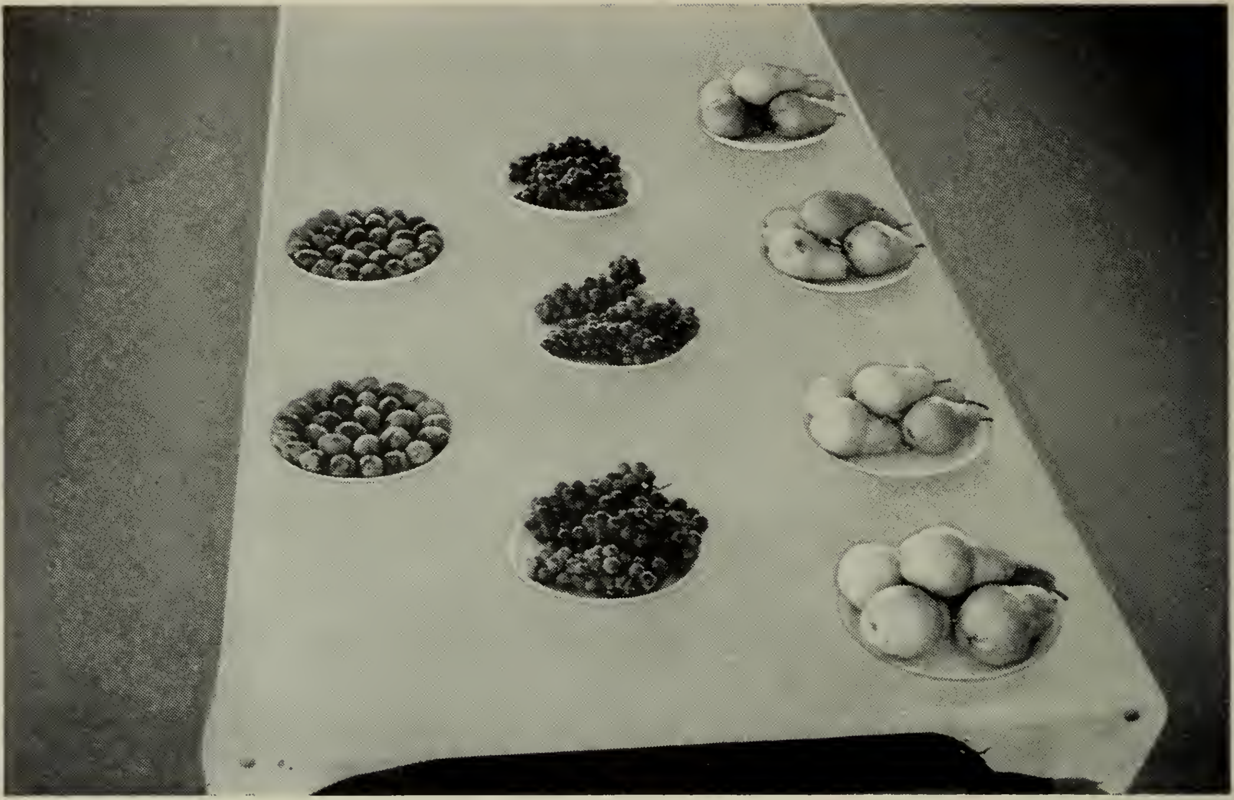


Fig. 8—Eight-inch paper plates are standard receptacles for showing most kinds of fruit.

Fruit

Condition	25
Uniformity	20
Colour	15
Size	10

CRABAPPLES

Crabapples are usually shown on standard plates; as many as required to complete one layer are placed on the plate. They are judged on the same points as apples and the same score card may be used. High colour and firmness are especially important with crabapples. Size is of lesser importance.

CHERRIES

Cherries are not commonly included in the prize list because horticultural shows are usually later in the year than the cherry season, and cherries do not keep long in storage. They may be exhibited on standard 8-inch paper plates, in pint or quart boxes, trays, or 6-quart baskets. A uniform type of display receptacle should be used. When plates are used, as many cherries as are required to complete one layer are placed on the plate. In most cases a larger quantity, i.e. 1 to 6 quarts, is desirable. When a 6-quart basket is shown the cherries could be packed so that only a small percentage of stems is visible. No leaves or twigs should be present in the basket.

Score Card for Cherries

Condition	35
Colour	25
Size	25
Uniformity	15

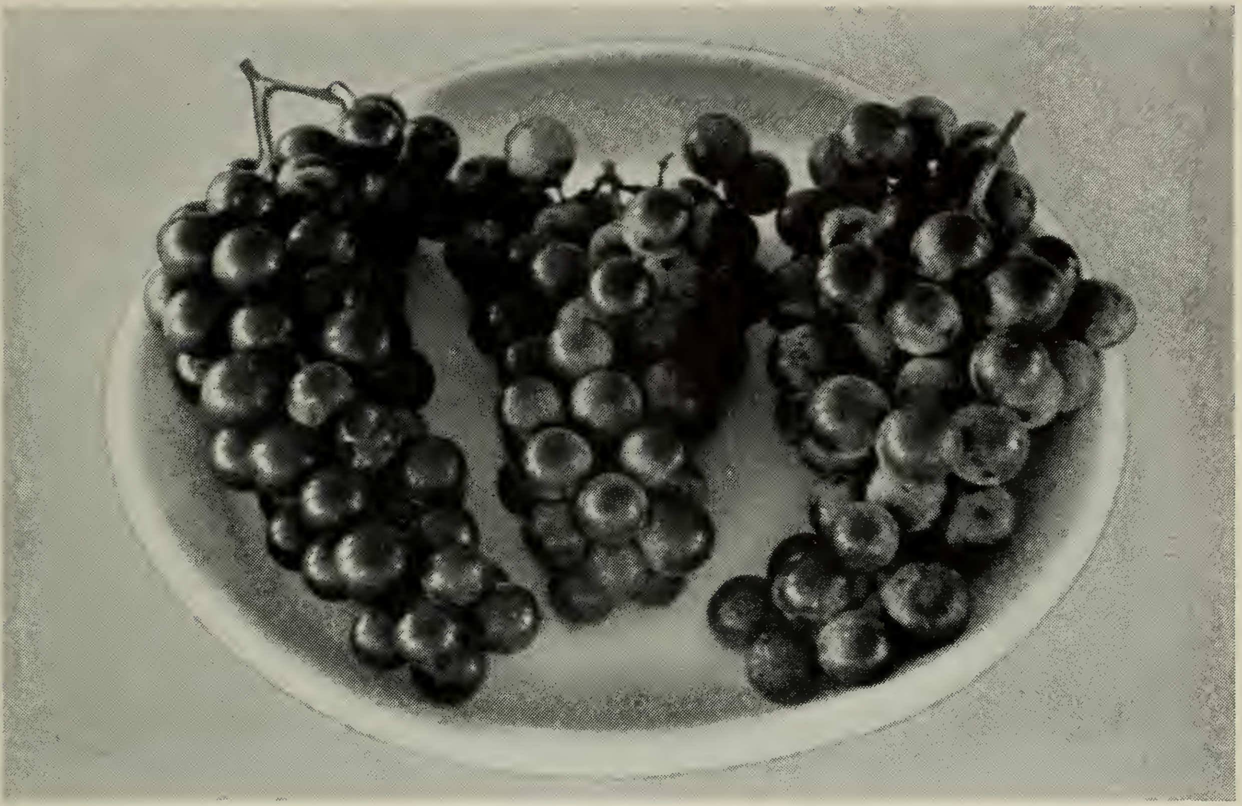


Fig. 9—A standard plate of grapes is comprised of three bunches.

Good condition in cherries means firmness of flesh, and freedom from scald, breaks in the skin, stemless specimens, insect injuries, spray residue, and other blemishes. Heavy deductions are made when any major blemishes are present.

Colour is an index of maturity and quality. The cherries should be fully coloured and the colour should be typical of the variety. Varieties vary in size, but the fruit exhibited should be well-sized for the variety. Uniformity includes condition, colour, and size.

GRAPES

Grapes are exhibited on plates or in 6-quart baskets. The prize list should state clearly the receptacle to be used and the quantity to be shown. When shown on a plate the standard number of bunches per plate is three. Leaves or portions of canes should not be shown with the fruit. Grapes in baskets should be properly packed.

Score Card for Grapes

Condition	30
Uniformity	20
Compactness of bunch	15
Form and size of cluster	15
Form and size of berry	10
Colour	10

When judging grapes, heavy deductions are made for major blemishes, such as those caused by disease or insects. The berries should be sound, fresh, firm, mature, and with plenty of bloom for the variety.

There should be uniformity as to size, form, colour, etc., among the berries in a cluster. Uniformity among the clusters on the plate or in the basket is also important.

Deductions are made for lack of compactness for the variety, that is, where the cluster or bunch is "loose" as a result of being poorly filled. A rather loose bunch is characteristic of some varieties, such as Ontario and Portland.

The clusters or bunches in an entry should be of good size and typical of the variety as to form or shape. In varieties such as Concord, where a shoulder is characteristic, the shoulder should be well developed. The berries should be of good size for the variety. Well-developed colour is a sign of maturity and is highly desirable. "Green" or "white" varieties, such as Niagara, develop a rich golden finish when properly grown and mature.

PEACHES

When peaches are shown on plates the standard number per plate is five. Peaches can be attractively exhibited in 6-quart baskets. If shown in standard peach boxes, an accepted commercial pack should be used. The prize list should state the type of container and the type of pack to be used, and whether baskets are to be covered or open.

Score Card for Peaches

Condition	30
Uniformity	20
Colour	20
Size	20
Form	10

Condition

The peaches should be sound, clean, and free from blemishes such as insect injury, limb rub, sun scald, skin punctures or breaks, diseases, growth cracks, gum, and bruises. Specimens with split pits are highly undesirable. A split pit which is readily apparent is considered as a major blemish.

Uniformity

The specimens in an entry should be uniform in size, colour, and form. When the box or basket is used, the peaches should be correctly packed and show uniformity of grade throughout.

Colour

Colour is important with peaches and highly colored varieties such as Redhaven are especially attractive. The ground colour, under colour, or background colour of a peach is an index of maturity. It is a yellow-green when the fruit is ready to pick and becomes more yellow as it ripens. A peach that is ripe for eating is more attractive than the same peach in a commercial pack where a certain degree of firmness is required. The prize list should specify "commercial pack" or "ripe for eating."

Size

The most acceptable commercial size should be considered as the ideal. The size for Select Grade of peaches is 2⅜ inches in diameter (Ontario Farm Products Grades and Sales Act, 1951). The choice of size will be governed to some extent by the type of pack used.

Form

Varietal characteristics of peaches are not so obvious as with other kinds of fruit. Nevertheless, the specimens in an exhibit should be well formed and typical of the variety as named on the label.

Fig. 10—An exhibition of fruit should have educational value.

APRICOTS

The apricot season in Ontario is too early in the year for most horticultural shows, but apricots may be an interesting addition to summer exhibitions in certain districts.

Apricots are shown in a standard quart box or 6-quart basket. Good colour is especially important with this fruit. A rich, golden red blush on a deep yellow undercolour is characteristic of a properly mature apricot of high quality. Any green in the undercolour is particularly undesirable.

Apricots are similar to peaches with regard to the blemishes which may be present on the fruit to detract from its condition. Like peaches, they are subject to split pits, rot, gum and growth cracks. The score card for peaches may be used in the judging of apricots.

PEARS

Pears may be shown on plates, in standard pear boxes, or in baskets. When plates are used, five pears are placed on their sides on the plates with the stems toward the centre, or the fifth may be placed on the others in the centre. Boxes and baskets should be new, clean, and packed according to the acceptable commercial practice.

Score Card for Pears

Condition	30
Uniformity	25
Colour	15
Size	15
Form	15

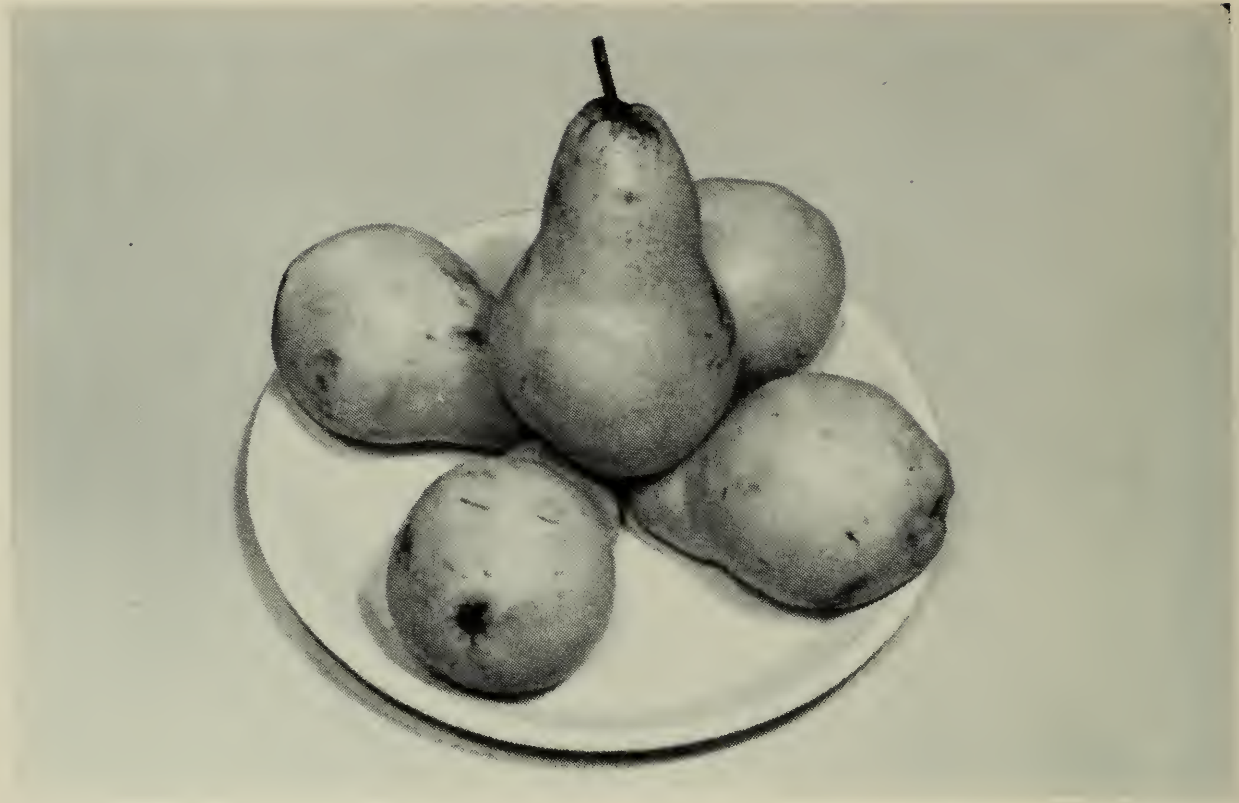


Fig. 11—When pears are shown on plates, the standard number of specimens is five.

Condition

The pear specimens should be firm and free from major blemishes, such as caused by insects, insect injury, diseases, scalds, spray burns, drought spots, breaks in the skin, and bruises. Examples of less serious blemishes are those caused by limb rub, leaf marks, honey dew and sooty fungus caused by psylla, and russeting which is not characteristic of the variety.

Uniformity

The specimens in an entry should be uniform in size, colour, and form. If one pear in a plate is off-type in form, the entry loses points under "form" and again under "uniformity".

Colour

Although colour is not as important with pears as it is with apples it should be typical of the variety. Some varieties, like Clapp Favourite, develop an attractive red skin colour. A brownish red cheek is characteristic of mature specimens of Anjou, Flemish Beauty, and Seckel.

The ground colour of pears is quite green at picking time and remains so in proper storage but it turns to yellow as the pears become ripe for eating. A pear which is ripe for eating is more attractive in both skin colour and ground colour than it was before ripening. Therefore, the prize list should state whether the pears are to be shown "ripe for eating" or "mature as for a commercial pack."

Size

The ideal size of pears is that which is most acceptable commercially for the variety. The minimum diameter for No. 1 Grade Bartlett, Kieffer, Bosc, and Sheldon, is 2⅛ inches (Ontario Farm Products Grade Sales Act 1951). Extra-fancy Grade pears packed in boxes are somewhat larger.

Form

Each specimen in an entry should be well formed and typical of the variety. Pear varieties are readily identified by the characteristic form of the fruit.

PLUMS

As many plums as are required to complete one layer are placed on a plate. The stems of the outer ring may be neatly placed toward the centre. Larger receptacles, such as 6-quart baskets, may also be used but should be properly packed. Damsons are usually shown in quart boxes.

Score Card for Plums

Condition	35
Uniformity	25
Colour	20
Size	20

The plums should be sound, ripe, not over-mature, and clean. Heavy deductions are made for blemishes such as those caused by insect pests and diseases, breaks in the skin, sun scald, heat or drought spots, russetting, and bruises. The entry should be free from stemless specimens.

The specimens in an entry should be uniform in size, colour, and shape. They should be of good colour and size for the variety. Colour is not always indicative of proper maturity. Some plum varieties such as Italian Prune colour before they are mature and too frequently are harvested in an immature state. Fruit thinning is often necessary with plums in order to secure good size.

QUINCES

Quinces are shown on plates. Five specimens are placed on their sides on the plate with the stems toward the centre of the plate, or the fifth may be placed on top of the other four. The fruit should be sound, firm, and free from insects, insect and disease injury, or other blemishes. The fuzz is usually left on the fruit.

Score Card for Quinces

Condition	30
Uniformity	20
Size	20
Form	20
Colour	10

ANY OTHER VARIETY

The class "Any Other Variety" is often included especially for apples, so as to give more exhibitors an opportunity to enter exhibits. Only those varieties for which there is no other class in the prize list qualify for this class. It is often a difficult class to judge because each entry may consist of a different variety. The difficulty is increased if no distinction is made between fall and summer varieties, between fall and winter varieties, or between dessert and culinary varieties. Therefore, the prize list should specify summer, fall, or winter, and culinary or dessert varieties.

As a guide, summer varieties are those which mature in the general season of Duchess and Melba, and would include also such varieties as Early McIntosh, Yellow Transparent, Lodi, Milton, and Red Astrachan. Fall varieties are those which follow the summer group in season, and include such varieties as Atlas, Baxter, Gravenstein, Joyce, Snow, Wolf River, and

Fifg. 12—As many plums as are required to complete one layer are placed on the plate.

Wealthy. Later varieties constitute the winter group and include Cortland, Bancroft, McIntosh, Delicious, Rhode Island Greening, Northern Spy, Sandow, Rome Beauty, Golden Delicious, Tolman Sweet, Spartan, Golden Russet, King, and Jonathan.

Score Card for Any Other Variety Class

Condition	30
Suitability	20
Colour	15
Size	15
Uniformity	10
Form	10

With regard to suitability, any apple can be used for either cooking or dessert but if a class is designated as "Any Other Culinary Variety" the culinary value of an entry is considered. For example, Cortland would be given preference over Cranberry in culinary value. Similarly, in a class calling for a dessert variety, Snow would receive preference over Wealthy.

With regard to colour, size, and form, each entry is compared with the ideal specimen of that variety rather than with the other varieties in the class. For example, the Cranberry specimens might be better coloured for the variety than the Cortland; the Wealthy may be a better size for the variety than are the Snow apples. On the other points, namely, condition and uniformity, the plates can be judged on a comparative basis.

SMALL FRUITS

Raspberries, blackberries, strawberries, currants, gooseberries, and blueberries are exhibited in standard pint or quart boxes, as specified. The box should be full and the container itself should be new, clean, and not marked with any identification. The prize list should state whether coloured bands or "tin-tops" are to be permitted.

Score Card for Small Fruits

Condition	50
Colour	30
Size	20

Small fruits on display, especially strawberries, are often a temptation to the public. For this reason, it is advisable to show these fruits in a wire-covered case.

Condition

The berries should be firm, dry, and free from rot, mould, insects, insect and disease injury, and green or over-ripe berries. There should not be any leaves or twigs in the box. The skins of currants, gooseberries, and blueberries should be free from breaks, punctures, and stings. The strawberries should retain the green calyx and ¼ to ½ inch of the stem. The raspberry entry should not contain any fruit with cores. Red and white currants should be shown attached to the "stem" or cluster, whereas black currants should be loose and free from stems.

Colour

Red fruit, for example, strawberries, red currants, red gooseberries, and red raspberries should be well-coloured and free from immature specimens. Solid red strawberries are preferred to those with green tips. Black currants and blueberries should be free from green and partially ripe specimens.

Size

Large fruit is generally more attractive than small fruit and receives a higher rating on this point. With red and white currants large clusters or bunches are given preference over smaller ones.

FRUIT COLLECTION

A fruit collection consists of a number of kinds and/or varieties of fruits in one exhibit. The number of specimens of each kind and variety should be clearly stated in the prize list. Collections are commonly placed in a specified area of space. The prize list should state what containers and decorative material may be used.

Score Card for Fruit Collections

Condition	30
Shape, size, and colour	25
General attractiveness	20
Variety and value of kinds	15
Uniformity	10

Condition

Each pecimen in a collection should possess, as far as possible, perfect condition. One specimen showing shrivelling, bruises, insect or disease damage, punctures or other such blemishes, detracts greatly from the score of the collection.

Where the number of kinds, or the number of specimens in a collection is not specified in the prize list, the size of the collection should be governed by the quality of the available material. It is to the advantage of the exhibitor to show fewer specimens, all of top quality, rather than to include in his collection an inferior specimen.

Shape, Size, and Colour

With fruit, the shape, size, and colour contribute to quality. Therefore, each specimen should be well-formed and typical of the variety. The most acceptable commercial size for the variety should be considered as the ideal. Good colour is an index of maturity and quality as well as adding to the general attractiveness of the exhibit.

General Attractiveness

General attractiveness ranks high in the scoring of a collection because it involves a number of important points. Balance, colour, arrangement, choice of material, and quality are all factors which influence the general attractiveness of a collection.

Diversity and Value of Kinds

Other points being equal, preference is given to the collection with the greatest diversity of kinds. Quality should not be sacrificed for quantity. Some kinds and varieties are of greater horticultural value than others. For example, pears are considered to be of greater value than quinces; in apples, McIntosh is preferred to Ben Davis.

Uniformity

Generally, the prize list for a collection calls for more than one of each kind. Therefore, all the specimens of the same kind or variety should show uniformity in size, colour, and shape.

FRUIT DISPLAYS

The main purposes of a fruit display are (a) to add to the attractiveness of the show, and (b) for commercial advertisement. The display may or may not be entered in competition. The display generally takes up considerably more space than a collection. It should occupy a position of prominence and be well lighted to give it full effectiveness.

A fruit display may consist of several kinds of fruit, for example, it might include peaches, cherries, and plums. It might consist of only one kind, for example, a display of peach varieties. Or, a display may comprise one variety only, for example, a display of Golden Jubilee peaches. Some decorative material is often included to help set off the fruit to the best advantage.

The prize list should state whether the fruit in the display may be shown loose, what containers and decorative material may be used, and the space to be occupied. If the display is for competition the prize list should state what kinds and/or varieties are to be shown.

PRESERVED FRUIT

As previously mentioned, preserved fruit is judged entirely by appearance in a horticultural exhibit. Although appearance is not 100 per cent indicative of quality, it is generally true that an entry which ranks high in all points as judged by appearance will also be high in quality. It is seldom advisable for the judge to open any of the containers, although this may be necessary on occasions.

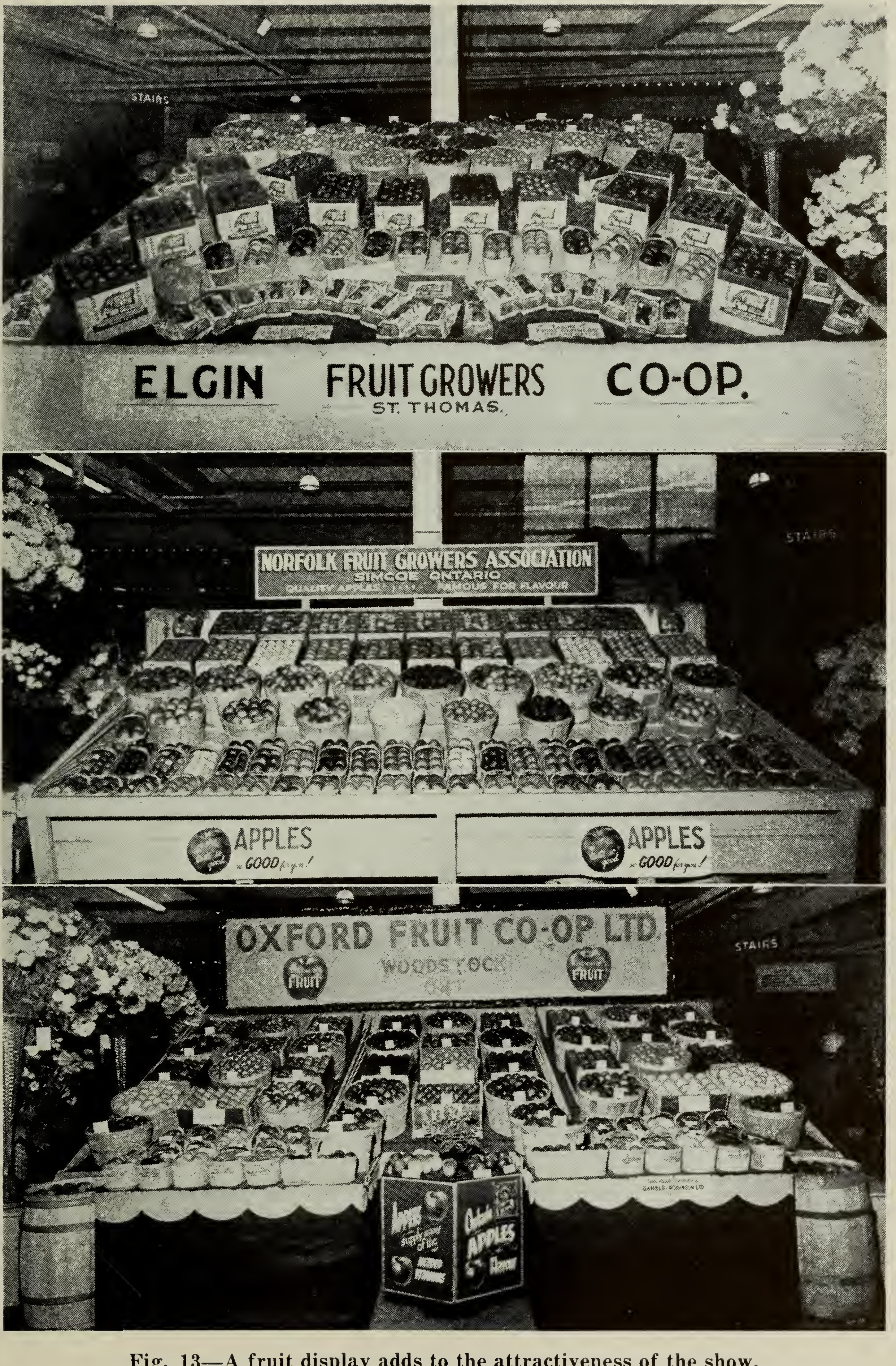


Fig. 13—A fruit display adds to the attractiveness of the show.

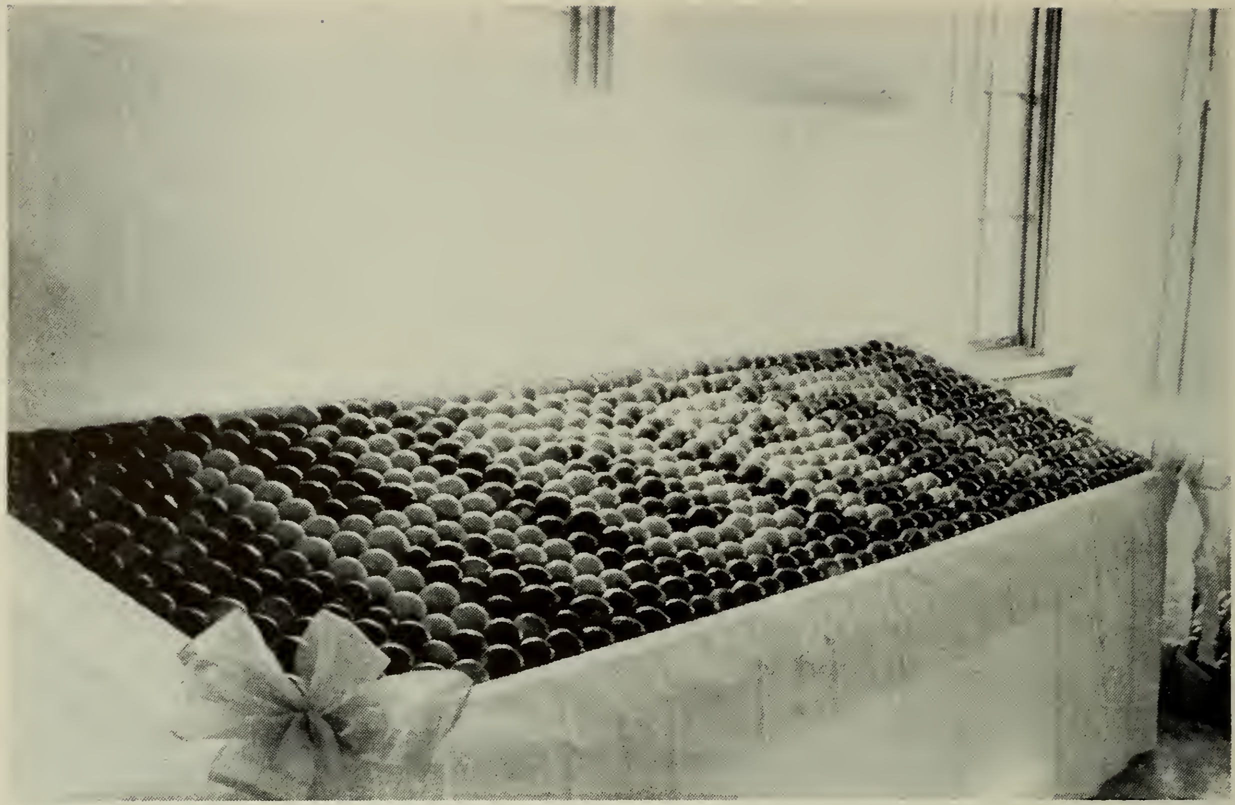


Fig. 14—A display may consist of several kinds of fruit, or of one kind only as this apple display.

Score Card for Preserved Fruit

Condition of fruit	30
Colour of fruit	20
Clarity of liquid	20
Fullness and neatness of pack	10
General attractiveness	10
Labelling	10

The preserved fruit, whether whole or cut, should appear sound, firm, and unbroken. The pieces should be of uniform size and shape.

The ideal colour for any preserved fruit is that of the fresh product. It should retain as much of the natural colour as possible.

The liquid should be clear, that is, free from solid particles. This can often be seen better by holding the container up to the light.

The container should be full and over half of the volume occupied by fruit. The fruit should be neatly packed in the container.

General attractiveness is of special importance because, if it is lacking, an entry receives a double cut. For example, if the colour is poor, the entry is scored down under "Colour" and again under "General attractiveness". The containers should be clean and uniform as to size and type.

Each container should be correctly and neatly labelled. The labels in an entry should all be of the same size and design, and should indicate the kind of fruit and the date on which it was preserved.

BULLETIN 490 MAY 1952

BEEKEEPING IN ONTARIO

FOR

HONEY PRODUCTION AND POLLINATION

●

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

Honeybees for Orchard Pollination

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS • TORONTO, CANADA

CONTENTS

PAGE

Introduction 5

Who May Keep Bees 5

Where Bees May be Kept 6

Handling Bees 6

How to Start Beekeeping 6

Hive Parts and Measurements 7

The Inhabitants of the Hive 10

Races of Bees 11

Honey Plants 11

Beekeeping Areas in Ontario 12

Spring Management 12

Swarm Prevention 17

Swarm Control 19

Supering 19

Removing the Crop 20

Fall Management 21

Winter Packing 23

Guide to Seasonal Management 26

Comb Honey 26

Handling Swarms 28

- Hiving a Swarm with Clipped Queen 29

Making Increase 29

Package Bees 30

- Ordering 31
- Care Upon Arrival 31
- Introduction to the Hive 31

Feeding of Bees 33

- Fall Feeding 35
- Spring Feeding 35
- Types of Feeders 35

PAGE

Uniting 35

Transferring Bees 36

- Transferring from Buildings, Trees, Etc. 36
- Destroying Swarms in Unused Buildings, Etc. 37

Robbing 37

Small Scale Queen Production 37

- Hopkins Method of Queen Production 38
- Method of Queen Rearing Used by Dr. C. C. Miller 38

Requeening 39

Moving Bees 39

- Short Moves 39
- Long Moves 40

Honey 41

- Preparation of Honey for Market 42

Beeswax 43

Beekeeping in Northern Ontario 45

Honeybees for Pollination 47

- Orchard Pollination 47
- Legume Pollination 47
- Greenhouse Pollination 48
- General Recommendations 48
- Payment for Pollination Services 49

Ontario Regulations Concerning Beekeeping 49

- The Bees Act 50
- Honey Grading Regulations 51

References 52

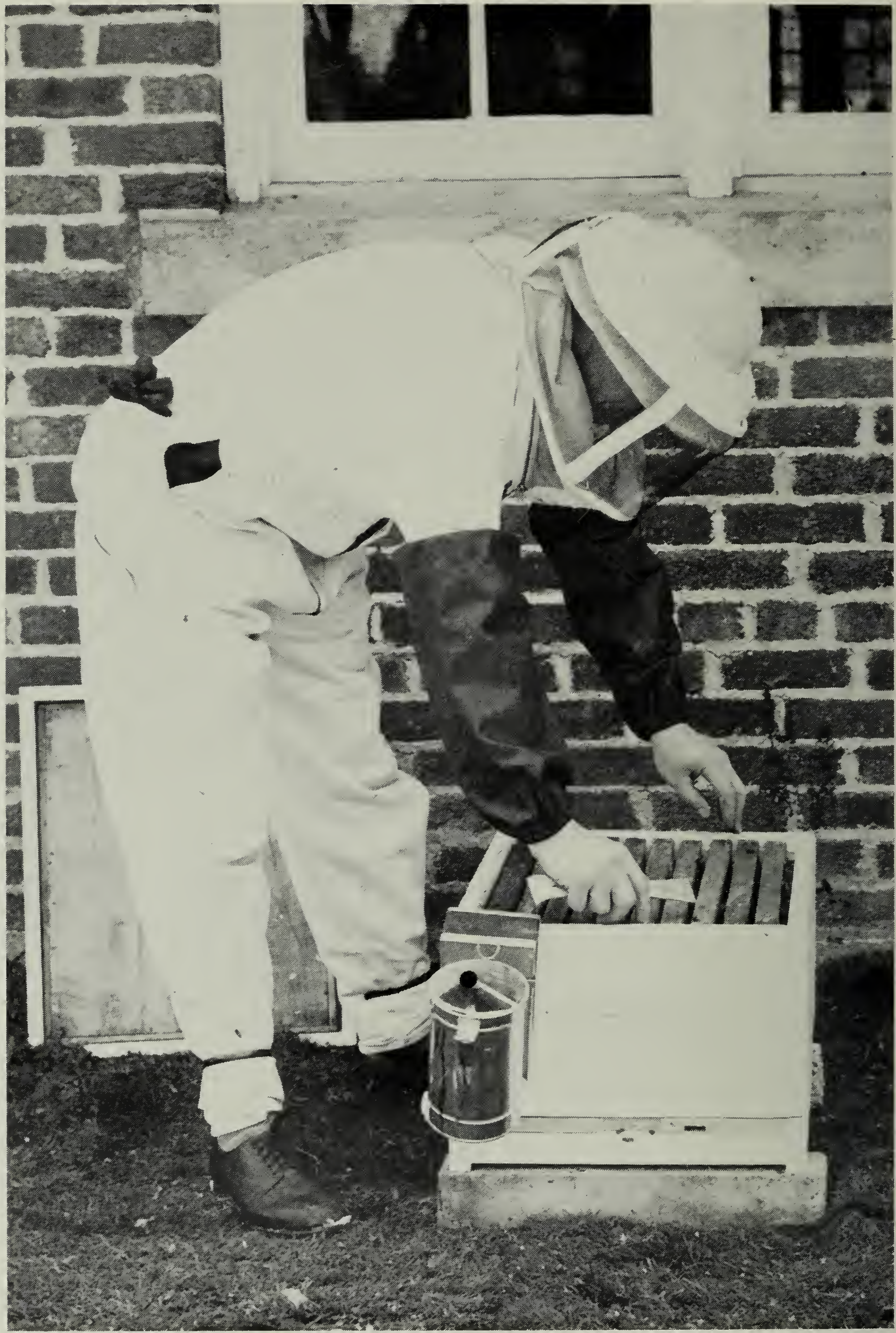


Fig. 1. Proper clothing and equipment are essential when working with bees.

BEEKEEPING IN ONTARIO

for

Honey Production and Pollination

by

G. F. TOWNSEND and P. W. BURKE

Ontario Agricultural College, Guelph

INTRODUCTION

Beekeeping is one of the oldest of agricultural pursuits. In the very early days the economy of several countries was based around beeswax and honey production. We are now finding that the economical production of many crops may be greatly influenced by the availability of honeybees.

While honeybees are used mainly for honey and beeswax production, these are only by-products compared to the service rendered for pollination. The cross-pollination of our many fruit and legume crops is the most important role played by the honeybee. This bulletin will attempt to present in a general way the necessary information in order to manage colonies of bees either for honey production or for pollination purposes. A special chapter is devoted to the use of honeybees for pollinating fruit and legume crops. In a general bulletin of this type it is not possible to cover in detail the various types of management. This information may be found in other pamphlets and bulletins as listed (Page 52). An understanding of bee diseases is very important, and attention is directed especially to "Bee Diseases and Pests of the Apiary," Ontario Department of Agriculture Bulletin 429.

There are approximately 5,000 beekeepers in Ontario operating in the neighbourhood of 180,000 colonies of bees. The annual production of honey in Ontario ranges between 7 million and 20 million pounds, depending upon weather conditions and flora available. In a good area under favourable conditions a colony of bees properly managed will produce annually 100 pounds or more of honey.

WHO MAY KEEP BEES

Bees may be kept by anyone who has ability, determination and courage as well as the interest to continue working with the bees in spite of the stings received. Bees are often kept as a hobby or for relaxation. Women often keep bees, but seldom keep very many colonies because of the heavy work involved. A few people are allergic to bees and may suffer from asthma or hay fever as a result of being stung. In certain individuals these symptoms may occur simply from a close association with bees or beekeeping equipment. Anyone showing symptoms of this nature should have as little to do with bees as possible, as there have been cases recorded where stings have proven fatal to such persons. Most beginners will swell to some degree from their first stings and it is only after receiving many more stings that a resistance to the swelling is built up. The initial pain at the moment of the sting is never lessened, but one becomes accustomed to the shock. The stinger should be scraped out as soon as possible but never pulled out as this presses more poison into the flesh.

WHERE BEES MAY BE KEPT

Bees may be kept almost any place where they can obtain sufficient nectar to provide food and where they will not make a public nuisance of themselves. There is no Act at the present time under which by-laws may be passed to prohibit the keeping of bees within any city, town or village. However, there is a regulation under The Bees Act which states that bees may not be kept closer than 30 feet from the nearest line fence, dwelling or cultivated field unless they are protected by a hedge or fence at least 7 feet high and extending 15 feet beyond the bees on either end. This law is to protect the bees from becoming a nuisance to neighbours and to help prevent them from flying into cars on highways. For best results colonies should be located in a sunny well drained spot where they are protected from the prevailing winds by shrubs or small trees. If possible the entrances should face south to southeast. Apiaries of over 25 colonies should be located approximately 2 miles apart. If placed closer together in most years both apiaries will produce less honey.

HANDLING BEES

The proper method of handling bees can only be gained through experience, but a few main points should be kept in mind. Do not become frightened of the bees. When one becomes frightened jerky movements are made and one tends to perspire, both of which antagonize bees and cause them to sting. It is necessary to work with ease at all times. Wear the proper type of clothing. Clothing should be as comfortable and cool as possible and yet give sufficient protection. Never wear anything made of wool or felt. Light cotton clothing is quite satisfactory. Do not provide places for the bees to crawl. All openings should be closed with zippers and the pant legs should be fastened with bicycle clips or tucked inside the socks. It is advisable to use tight fitting sleevelets. Shirt sleeves may be rolled to the elbow if the arms are not too hairy. Do not wear bee gloves unless absolutely essential, as they are too awkward. Always wear a veil as it is very disagreeable to be stung on the face. It is important to own a good sized smoker and have satisfactory fuel which will burn well and give a good cool smoke. There is nothing more annoying than to find the smoker out when it is wanted most. Carry out all operations very gently. Apply the smoke sparingly; experience will soon teach how and when to apply it. The best smoker fuel is dried Sumach bobs, but anything which will give plenty of cool smoke and continue to burn is quite satisfactory. Perhaps the most common fuels used are shavings and dried leaves. Burlap and old sacking are also satisfactory.

HOW TO START BEEKEEPING

Anyone considering beekeeping as a vocation should work with a commercial beekeeper for at least one season to gain a knowledge of beekeeping and at the same time find out whether he is suited to this occupation. Following this, it is advisable to attend the Annual Winter Short Course in Apiculture at the Ontario Agricultural College, and read as many books and bulletins as possible. The start should be made in a rather modest manner. The number of colonies should be increased gradually each year while full or part time work is continued. Colony numbers can be built up with much less expense by having beeswax made into foundation and by making increase rather than buying all of this material outright. This also affords an opportunity to expand the market for the product while production is increasing.

Those wishing to keep bees only as a hobby should purchase two or three colonies and not expand beyond this number until they feel that they are prepared to handle more colonies and have definitely decided that they wish to purchase more. Colonies may be started by purchasing package bees through one of the bee supply houses or direct from southern United States shippers whose names can be found in most bee journals, or by purchasing full colonies or nuclei from established beekeepers. When purchasing colonies or nuclei it is necessary to make sure that a certificate is received showing that the colonies have been inspected for disease. The purchase of either nuclei (3 or 4-frame colonies) or full colonies is quite often the most satisfactory means of starting. If they are purchased from a local beekeeper he will quite often give a little help and guidance in getting things under way.

HIVE PARTS AND MEASUREMENTS

The Standard Langstroth hive is recognized as standard equipment in the United States, Canada and several other countries. This hive is based on a discovery of the bee space by L. L. Langstroth in 1851. This space is considered to be ¼″ to ⅜″, and is an area around frames wide enough to allow the bees to pass through. Bees will not fill a space of these dimensions with propolis or burr comb. Factory-made equipment may be purchased from several bee supply houses, whose addresses can be found in most of the journals. Most commercial beekeepers feel that it is wise to buy factory-made equipment so that all measurements and cuts are uniform. Some, however, feel that it pays to make their own equipment. A person handy with tools and having the proper equipment available can quite readily construct his own equipment provided he adheres very carefully to proper measurements. If you plan to make your own equipment it is wise to purchase pieces of standard equipment and use these as a guide for measurements. It is important to adhere to the exact dimensions, as otherwise the bees will build propolis and burr comb, thus fastening tight the frames and other movable parts of the hive, making it very difficult to operate. If the spaces are too narrow it may lead to difficulties in swarm control. It is necessary to keep in mind that brood chambers and supers are made exactly the same, except that one is used for the rearing of brood and the other is used for the storage of honey, and that these two boxes and frames must always be interchangeable.

A standard colony for normal production consists of one bottom, one top, and three to five boxes which can be used for either brood chambers or supers. There should also be available ten frames for the brood chamber and nine frames for each super box. In addition are needed inner covers, queen-excluders, hive-stands, etc. Diagrams and measurements of each of these are included.

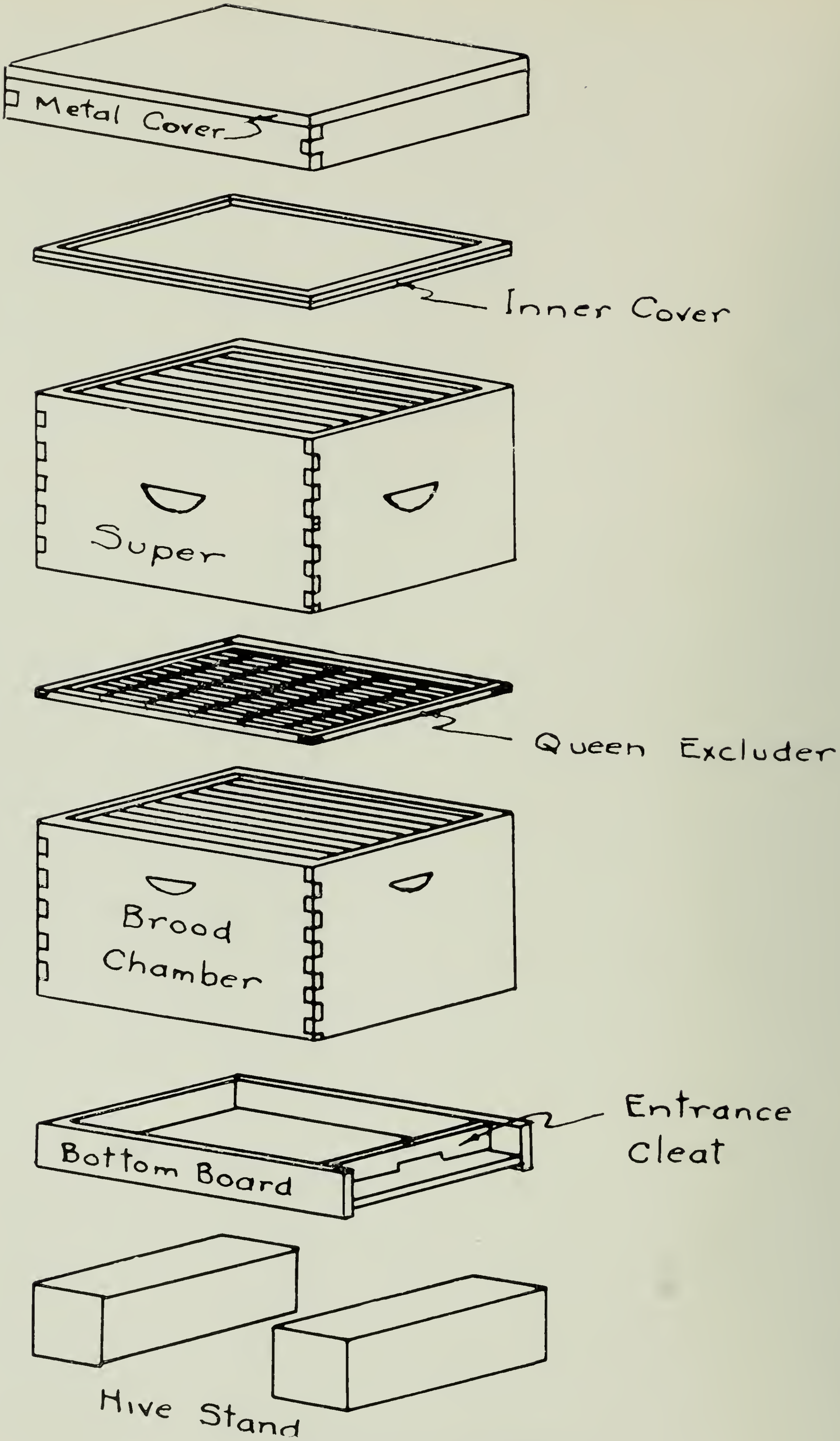


Fig. 2. Parts of a ten-frame Langstroth hive.

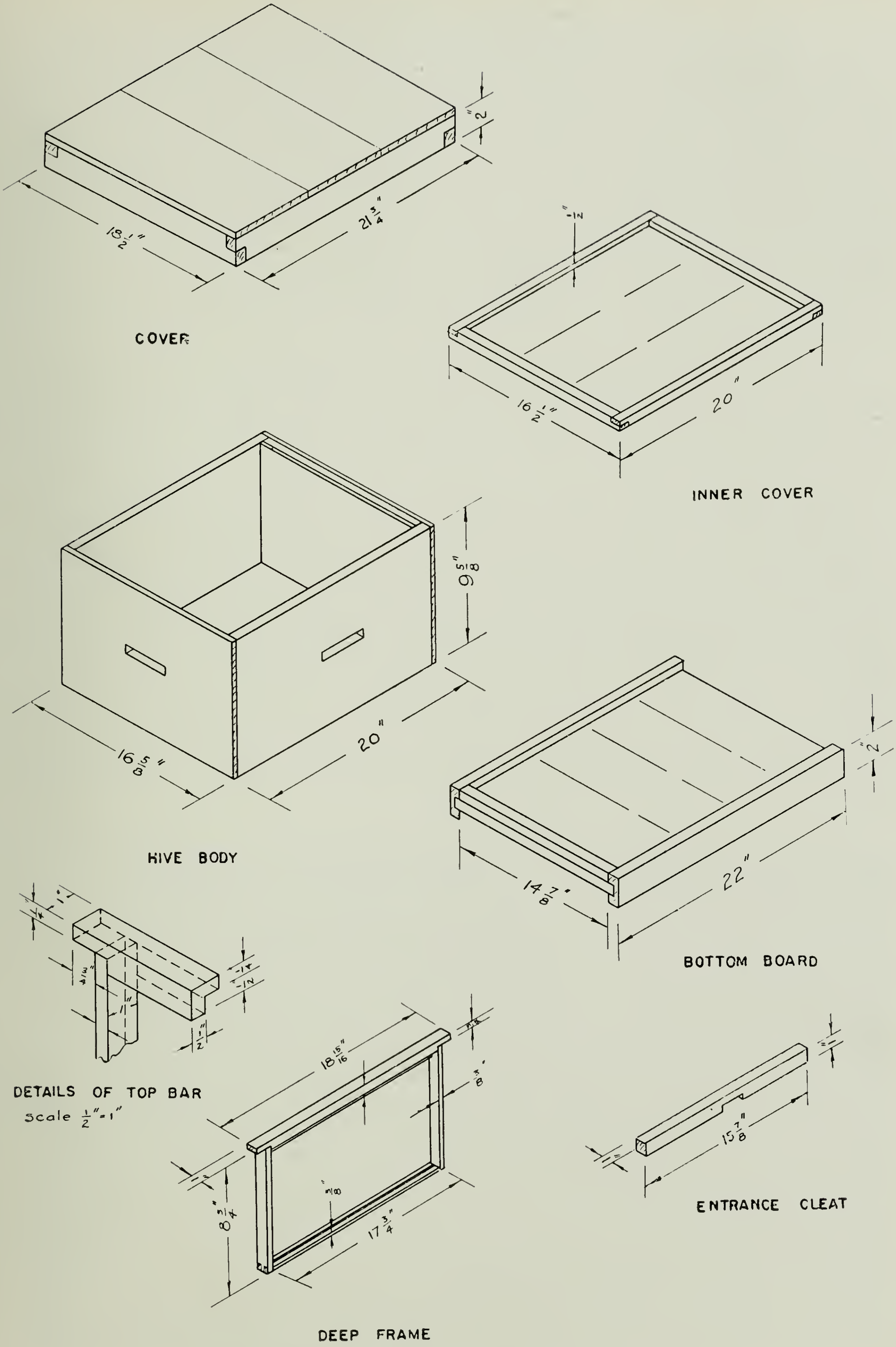


Fig. 3. Measurements of a ten-frame Langstroth hive.

THE INHABITANTS OF THE HIVE

A colony of bees consists of one queen, several hundred drones and up to 80,000 worker bees, or immature females. The only function of the drone is to mate with the queen, and once fall has arrived and there is no further need for drones they are all driven out of the colony. The queen is highly developed for egg laying. She will lay as many as 2,000 eggs in one day, or more than her own weight. The workers, or immature females, carry out all the active functions within the colony. The early part of their life is spent working within the colony, engaged in such duties as cleaning, feeding and guarding the entrance. During the latter half of their life they venture out to the field and eventually spend their last few weeks gathering nectar, often working themselves to death.

Since at the height of the season bees only live six to eight weeks, it is extremely important that brood rearing be kept at a peak during the spring build-up period, in order to make sure that plenty of young bees are coming on during the summer or honey flow period.

A queen can lay two types of eggs, and will do so, usually depending upon the size of the cells present. A maximum number of fertile eggs, which normally develop into workers, may be obtained by supplying the laying queen with combs drawn from good worker base foundation embedded in such a manner that the cells are not injured. These same fertile eggs if placed in special cells and provided with a special food are capable of developing into queens. Infertile eggs which develop into drones are laid in cells which are slightly larger. If the cells are stretched, or if the comb is broken or damaged and replaced by the bees, quite often the larger drone cells will be built and the queen will lay only drone eggs in these cells. To raise excess numbers of drones is wasteful as it requires considerable time and food and produces bees which are of little value to the colony.

For proper management of colonies, it is important to know the length of time which the bee spends in each of the four stages of development. The following table gives this information:

Average Life Cycle of the Honeybee

Stage	*Queen*	*Worker*	*Drone*
Egg	3 days	3 days	3 days
Larva	5½ days	6 days	6½ days
Pupa	7½ days	12 days	14½ days
TOTAL	16 days	21 days	24 days

When examining a colony to see how it is progressing, it is important to remember that it is not always necessary to find the queen. The conditions within a colony can be determined quite quickly by examining one or two frames of brood. If eggs are present in a uniform pattern on one or more combs, then the queen is doing well. If during the spring and early summer there is 20 pounds or more of feed stored on the outer edges of the combs around the brood nest, then there is sufficient feed for the time being. If there is not sufficient feed or honey present in the combs, then sugar syrup should be fed (see Page 33). It is also necessary to make sure that some pollen is present, otherwise brood rearing may decrease. If the bees are short of pollen during the spring build-up period, then pollen supplements can be used. Honey or sugar syrup and pollen constitute the complete diet of the bee, both for the adults and the larvae or brood, and should be present in sufficient quantity at all times. There are very few sections in Ontario where there are pollen shortages, and these usually occur only in wet cool springs. If a pollen shortage is encountered a pollen substitute can be made by mixing six parts of soybean flour (expeller processed) and one part of brewers' yeast. This material is then stirred into a sugar solution to make a stiff dough. The sugar solution is made by dissolving two parts of sugar and one part of water. This cake of pollen is then placed on top of the combs in direct contact with the brood nest.

RACES OF BEES

There are several races of bees common in America. The most important of these are the Italian, the Caucasian, and the Carniolan. The Italian bee is the one most generally used through the American Continent at the present time. The Italian bee is more resistant to some of our diseases, has less tendency to swarm, and winters well in the northern climates. The Caucasian and Carniolan bees are darker and the queens are more difficult to find. Some of the darker strains build up a little earlier in the season and require much earlier attention than Italians, and therefore may tend to swarm. The Hybrid bees which have recently been developed by research work and the use of artificial insemination are crosses between several strains of Italians or several strains of Caucasians and Italians. There is every indication that when this work has been carried to completion we will have bees which are much superior.

HONEY PLANTS

Ontario is best known as a white honey producing area, with the bees getting surplus crops of so-called white or clover honey from the common white Dutch clover that is found in lawns, sweet clover, alsike and occasionally

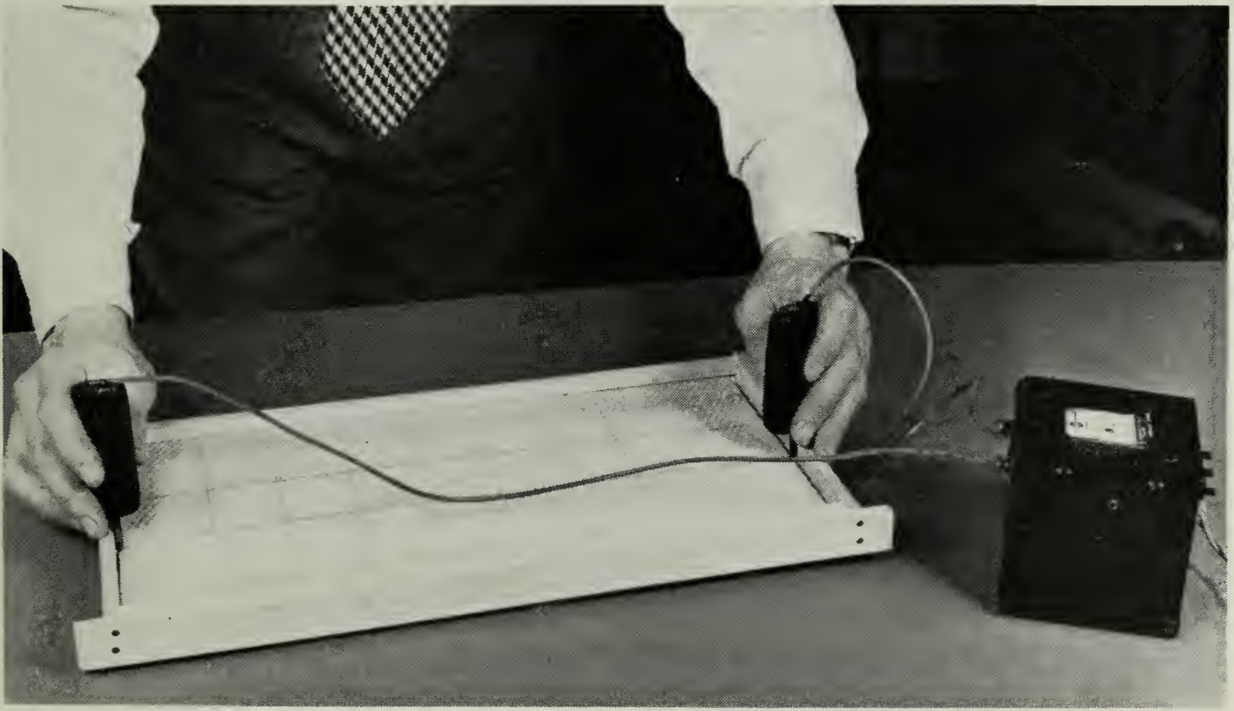


Fig. 4. Embedding the wire in Foundation with a 6 volt transformer.

red clover. One of our common forest trees found in farmers' woodlots, namely: basswood, secretes considerable quantities of nectar some seasons and produces a good quality white honey. Fireweed, which is sometimes a first succession plant after a forest fire and is plentiful in areas of Northern Ontario where the bushland has been burnt off, also produces white honey. Blueweed (Echium vulgare) is an important honey plant in many parts of Ontario and particularly in Hastings and Lennox and Addington Counties. Certain areas in Ontario produce considerable quantities of buckwheat honey, which is produced from the buckwheat which farmers grow for grain and the total production of this dark honey will range from 5 per cent to 35 per cent of the total crop.

While the above-mentioned plants are the most important from the standpoint of obtaining a surplus crop for the beekeeper, many others are important to the colony to keep brood rearing at an increasing rate and to supply the bees with feed during the seasons when the major honey plants are not in bloom. Honeybees require large quantities of pollen, which is their source of protein, for growth of the brood. Many of the so-called minor honey plants are large suppliers of this pollen. The common pussy willow, dandelion, fruit bloom, golden rod and aster are considered minor honey plants and good sources of pollen.

BEEKEEPING AREAS IN ONTARIO

The beekeeping areas in Ontario vary according to flora, soil conditions, weather, and general farm practice. It is important to know some of the factors which influence the growth of clovers, and also to know the general areas where good crops may be expected. For proper development, clover plants require fairly high lime soils, and soils which are rather fertile, containing fair amounts of phosphorus and potash. Alsike, which will grow on the slightly acid soils, is perhaps the only exception to this rule. The factors which affect the growth of clover will definitely affect the yield of nectar. Good honey crops are usually obtained in a year following a summer with a fair amount of moisture, which usually produces very good clover fields. A study of the following maps will give some idea of the better honey producing areas within the Province. The information given is according to county averages. There may, however, be an overlapping of conditions along the borderlines and some sections of a county may not be typical of the average for the whole county.

SPRING MANAGEMENT

When spring has officially arrived according to the calendar, most beekeepers become rather anxious to examine their colonies and see how they have survived the winter. If a plentiful supply of feed has been given to the colonies the fall previous, it should not be necessary to examine any colonies until the winter packing has been removed during the latter part of April or early May, depending upon the season and the location in the Province. Colonies in the very southern part of the Province may be safely unpacked sooner than those to the north. However, if it is necessary, due to a low supply of feed in the fall, to examine colonies during early March, the top packing should be removed and the feeding done as quickly as possible. The best plan is to give two or three combs of honey, if they are available, or two or

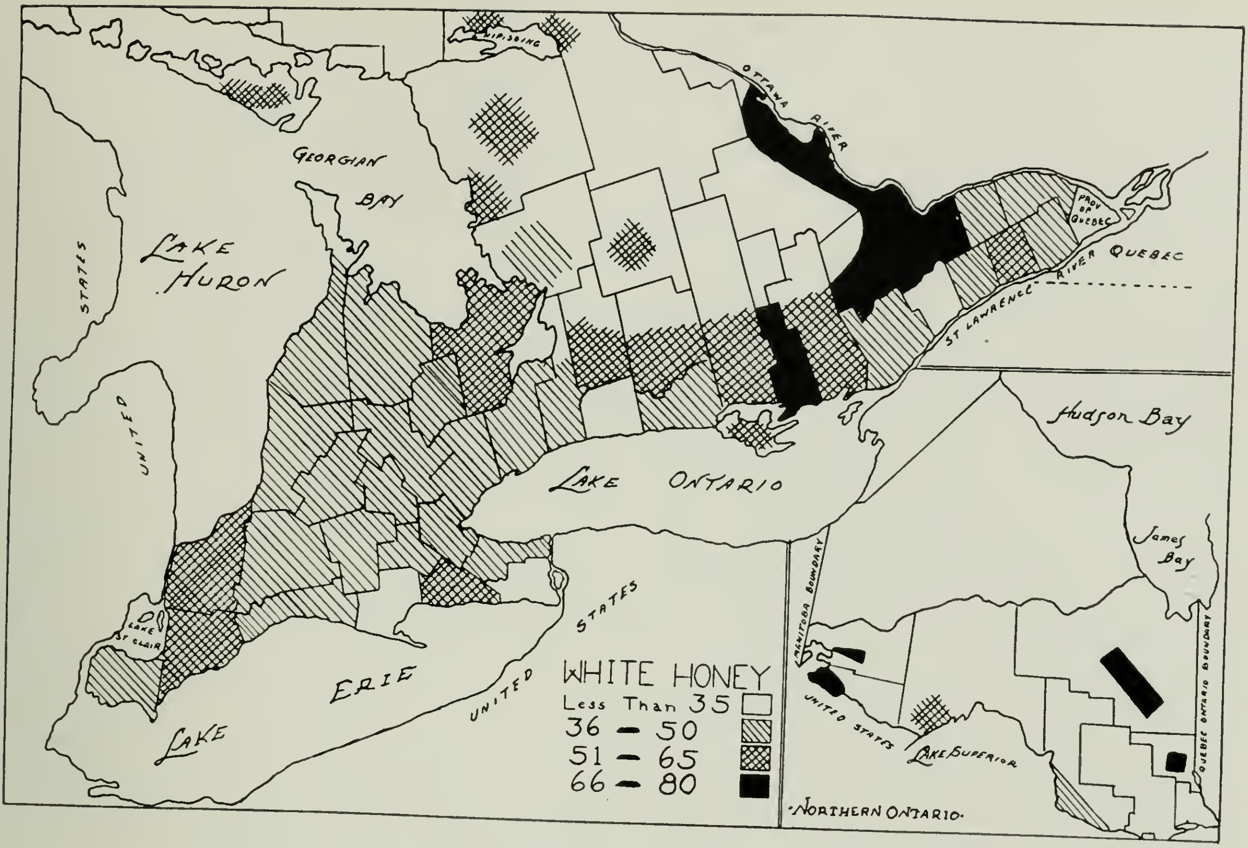


Fig. 5. White honey production in pounds per colony (1940–49).

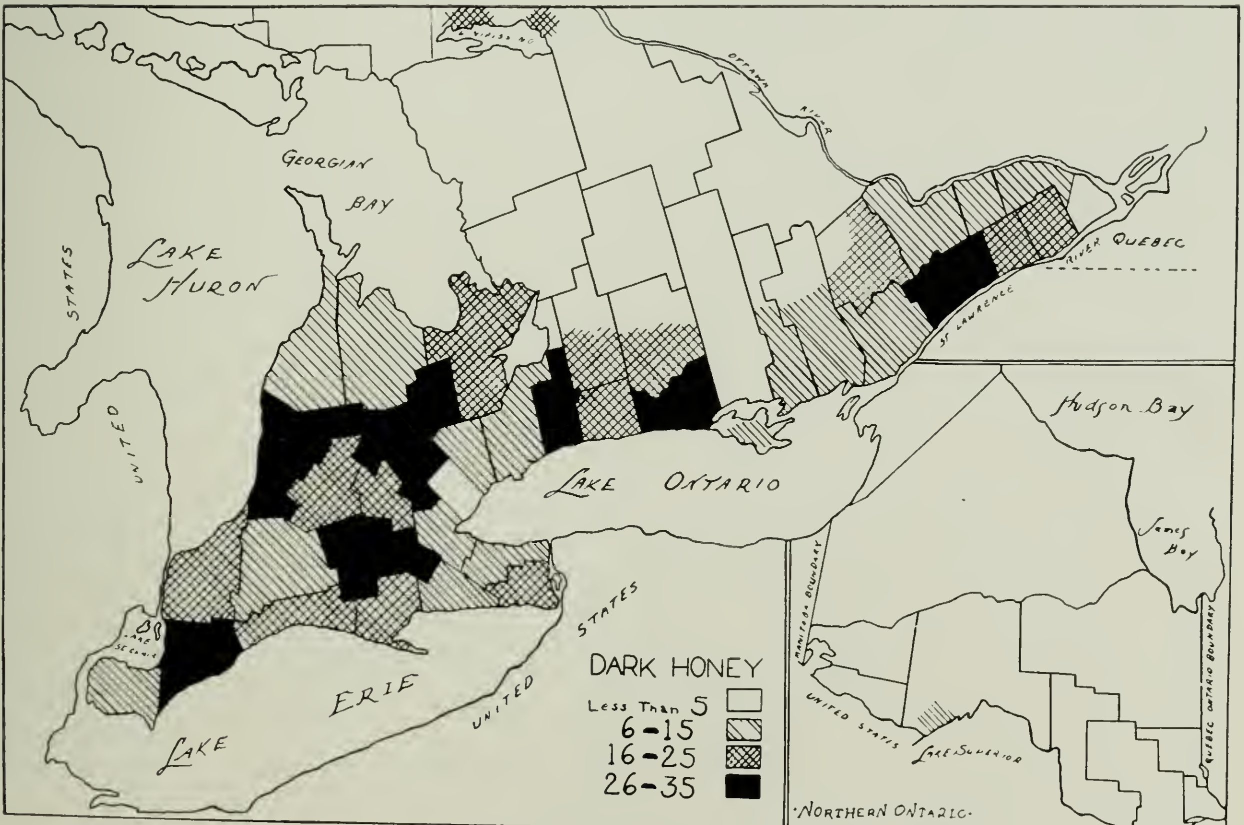


Fig. 6. Dark honey production in pounds per colony (1940–49).

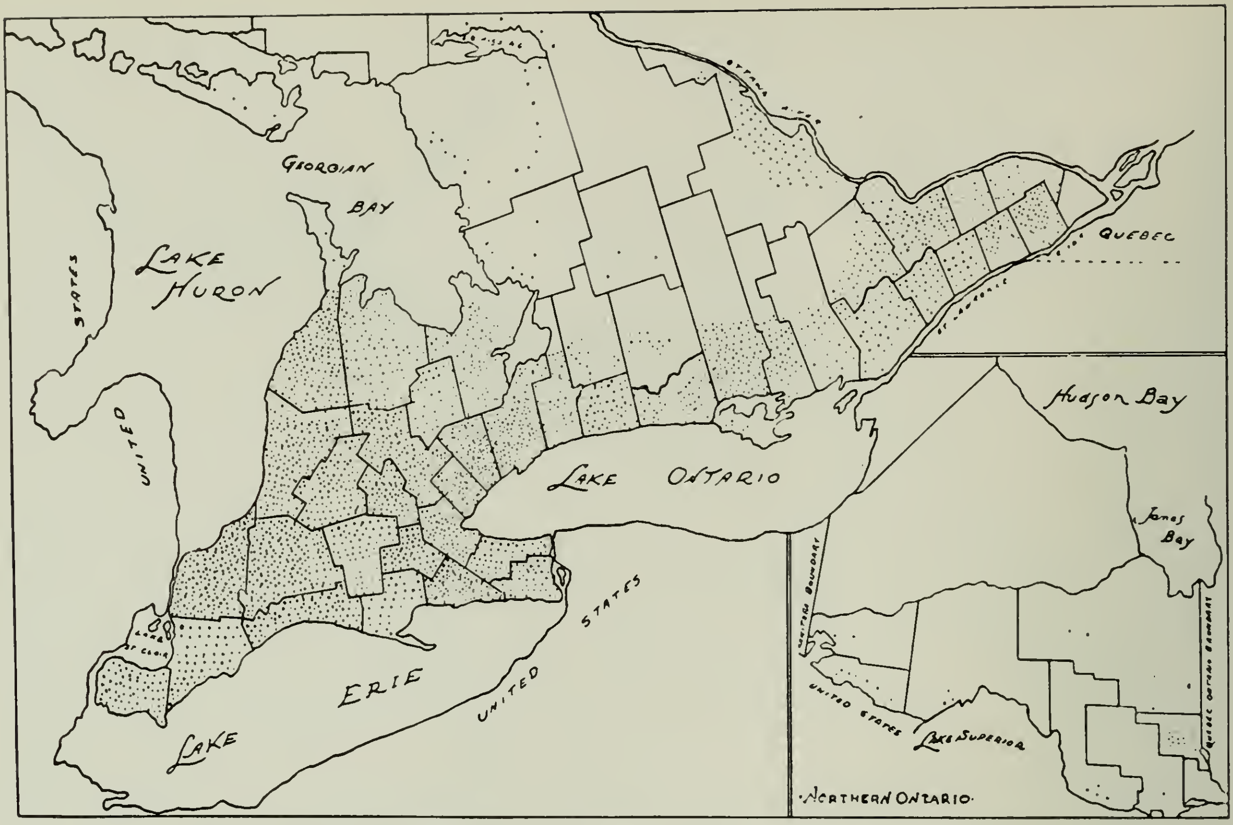


Fig. 7. Honeybee population by Counties. Each dot represents 50 colonies.

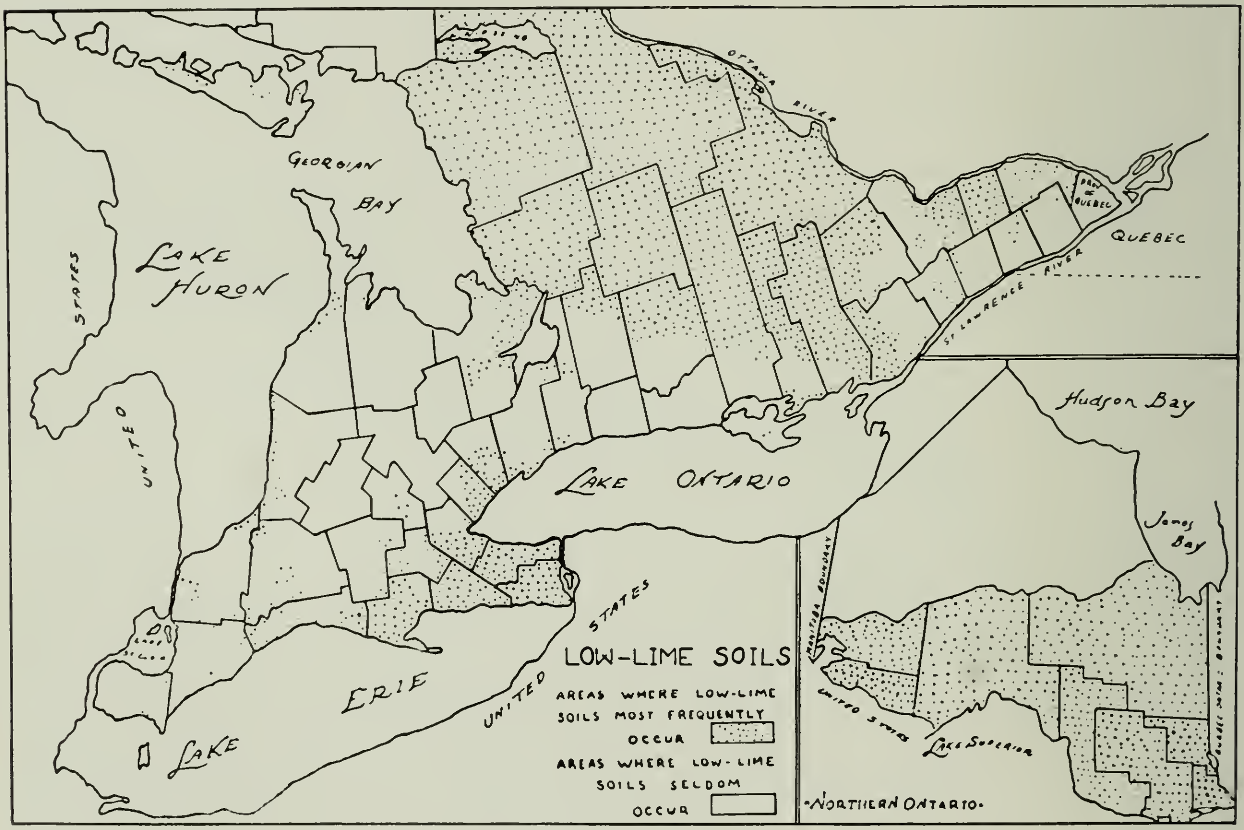


Fig. 8. Soil lime conditions in Ontario.

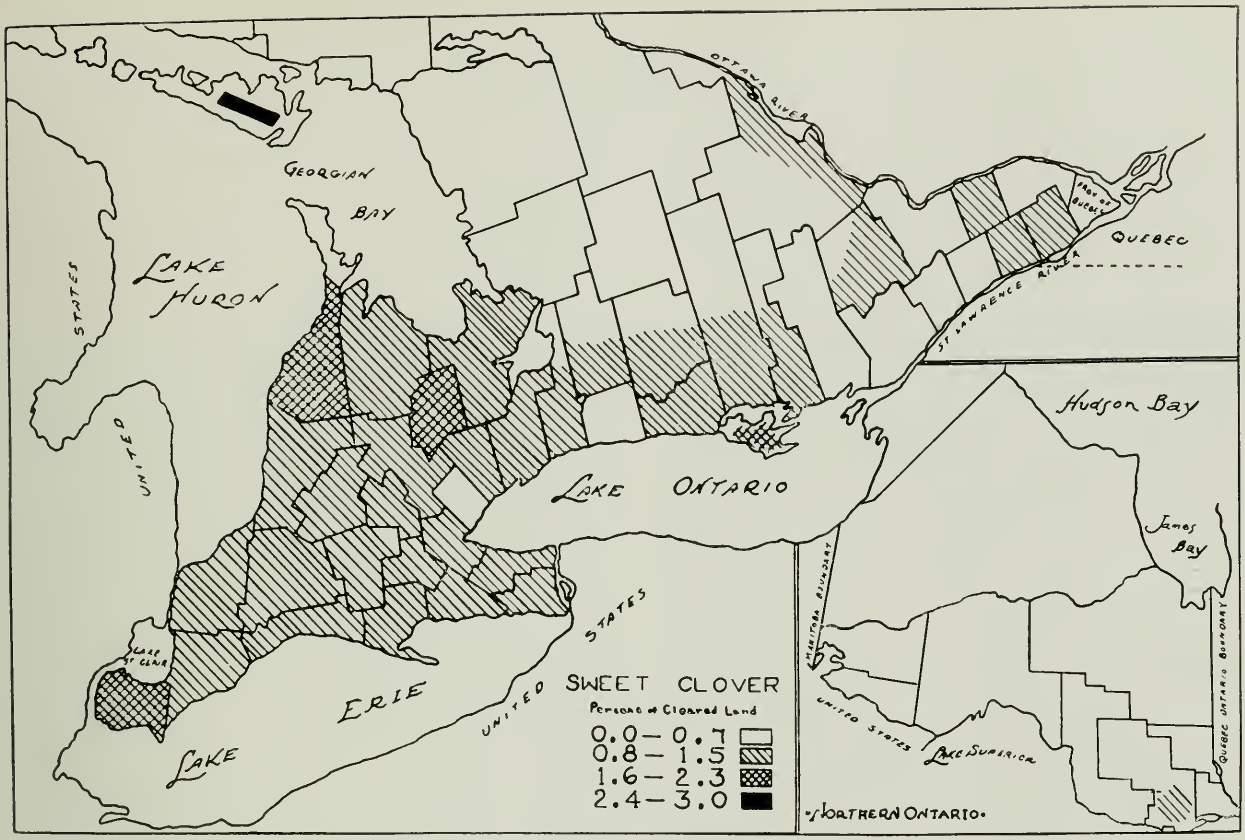


Fig. 9. Sweet Clover acreage as per cent of cleared land in each County.

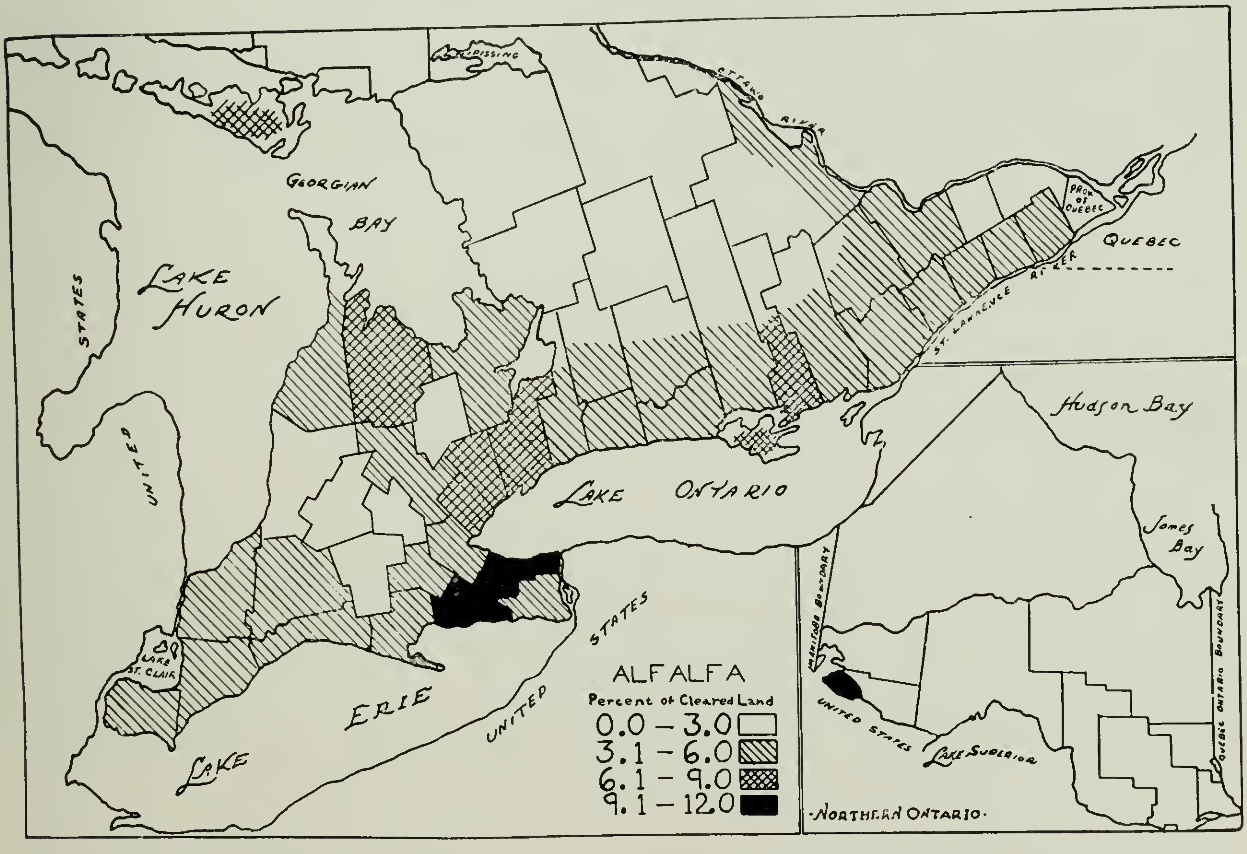


Fig. 10. Alfalfa acreage as per cent of cleared land by Counties.

three combs filled with a heavy sugar syrup. Most good strength colonies will require at least 20 to 30 pounds of feed to carry them from early March to early May. It is during this period of brood rearing in cool weather that both feed and protection in the form of winter packing are very necessary.

As soon as colonies are unpacked an examination should be made to see that the feed supply is sufficient and to ascertain by the presence of capped brood whether or not the colony has a queen. In most cases it will not be necessary to completely remove any combs from the colony to determine whether or not there is feed and brood present. This may be determined quickly by looking down between the frames, as the feed and brood will be seen there. Any colonies that look seriously weak should be checked for disease, and if found to contain American Foulbrood the necessary steps should be taken to destroy them. It may be necessary at this time to unite any weak or queenless colonies and also reduce the entrances to prevent possible brood chilling.

Routine spring colony manipulations usually start during the time the dandelions are in bloom. If the weather is favourable for nectar secretion from this plant, colonies will increase brood production rapidly, will soon become crowded, and unless handled properly will make preparations to swarm. The first examination would likely be ten days to two weeks after the unpacking and the interval between the two colony examinations would depend upon the amount of feed left in the colony and the weather. During seasons when the bees are able to fly and gather nectar and pollen from floral sources it would not be as necessary to examine them as closely for feed as in the case where they obtain very little nectar and pollen from the fields. It is especially important to make early spring examination on colonies that have a low feed supply and a high brood rearing potential due to a large population of bees and a good queen. Regular colony examinations made at intervals of eight to ten days will be necessary from the above-mentioned time in May to the beginning of the main honey flow and possibly one week after commencement of this flow, or until the first week in July.

From the time of the dandelion flow to the beginning of the clover nectar flow it will be necessary to examine colonies for such things as feed, failing queens, and lack of brood rearing space. Colonies should not be restricted in their brood rearing area prior to the main honey flow. By providing ample brood rearing space (even three supers of brood combs) a very populous colony will be obtained which would have strength to produce the maximum surplus crop.

The amount of available feed may be judged on general appearances, but a colony should never have less than 20 pounds of feed to keep brood rearing going at an increasing rate, as the bees seem to instinctively reduce their brood rearing when feed becomes scarce. Feed may be estimated at the rate of 5 pounds for a filled comb or its equivalent. There is a period between the dandelion and clover blossoming when little or nothing is available for the bees. Colonies could starve due to a food shortage some seasons, and this must be kept in mind during that time.

When colonies are operated on double or multiple brood chambers many queens lose their fertility during May and June. Even good colonies that go through a May or June supersedure receive a considerable set-back. Therefore any colonies which are showing indications of having a failing queen or one that is likely to be superseded should be requeened. Queens of good quality will have large areas compactly filled with brood, with little or no appearance of empty cells. Queens that are tending to fail lay in less compact areas and also have eggs more scattered. Requeening should be carried out as outlined under that heading.

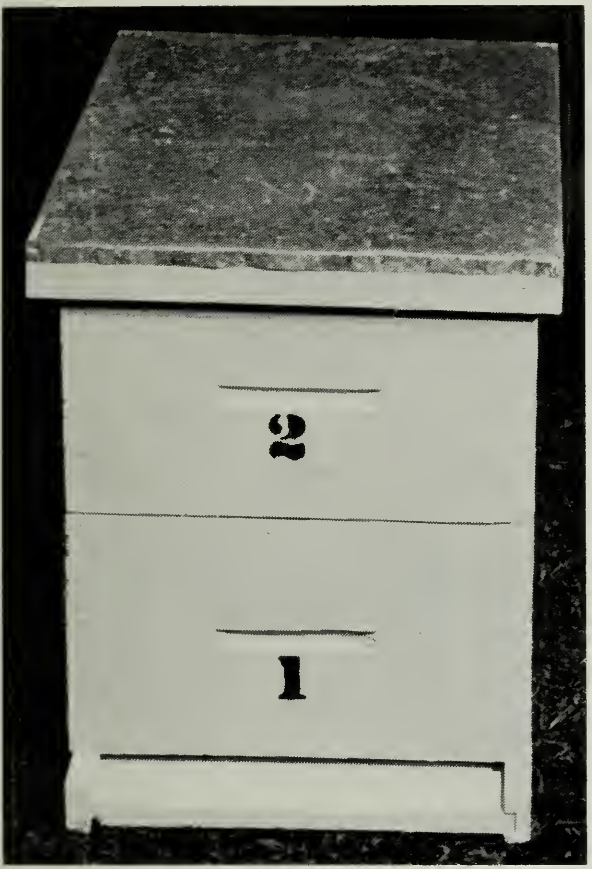


Fig. 11. Double brood chamber colony immediately after unpacking.

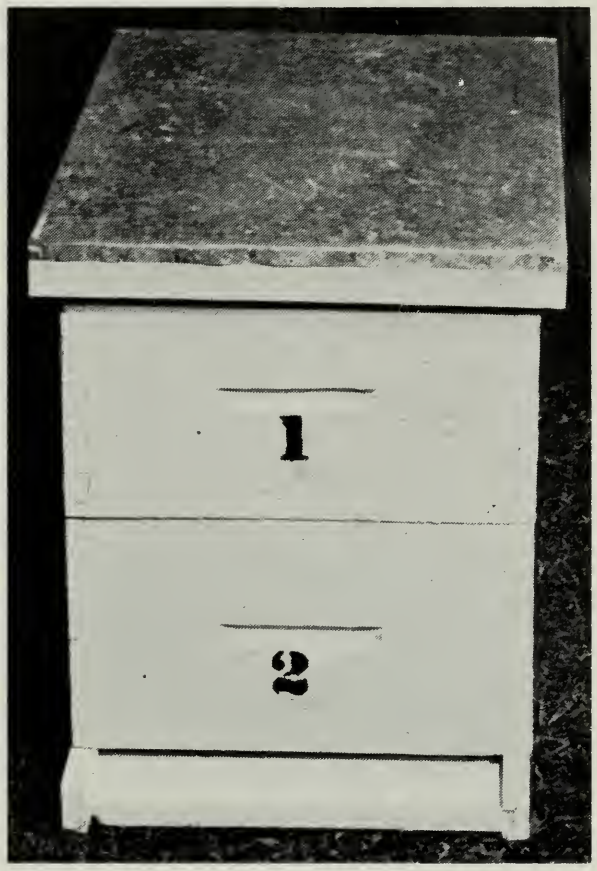


Fig. 12. Same colony with positions of upper and lower brood chambers reversed.

SWARM PREVENTION

Although queens will lay in newly built white comb, they do prefer dark combs for this purpose. Extra brood rearing space may be provided for by adding another hive body of combs to that already on a colony. One of the simplest systems of management to prevent swarming is the use of a double brood chamber, whereby the position of the two brood chambers is reversed periodically. At the commencement of the dandelion nectar flow most colonies will be occupying all of the upper brood box and the lower box will be nearly empty. At this time the position of these two brood chambers may be reversed so that the upper one which contains considerable brood and honey is placed on the bottom board with an entrance reducer and the lower box placed on top. Under these conditions bees work upwards in their brood rearing activity and in a few days the upper box will be occupied with new brood. Considerable honey may also be moved up from the now lower brood chamber. This manipulation actually does two things. Firstly, it makes empty comb space more readily available because the empty box is in the upper position. This relieves any crowding in the brood chamber. Secondly, because the honey that is placed next to the bottom board is moved upward by the bees it acts as a stimulant to increasing brood production. Another advantage of this operation is that no further equipment is required at this time. The original reversing of the positions of the two brood chambers should keep the colony in good order for possibly two weeks, after which time some colonies could be reversed again. This second reversing will depend entirely on the amount of empty space available in the box number 2 which is on the bottom board. Any subsequent reversing should be done only after examining the condition of the brood boxes to be sure that this second manipulation is necessary. If the colony is occupying most of the space within these two brood chambers, then it would be well to add a third set of combs directly on top. If any colonies show a tendency to prepare for swarming as indicated by the building of queen cells, destroy all the cells and put the third super of empty combs in between the original two.

When more than one hive body is used for brood chamber purposes the tendency of a colony to prepare for swarming may be observed by moving the upper brood chamber slightly forward and then raising the front end so that the bottom part of the frames may be seen. If queen cells are present in the colony some are usually visible along the lower edges of the combs of the upper brood chamber. Where such cells are found the whole brood chamber

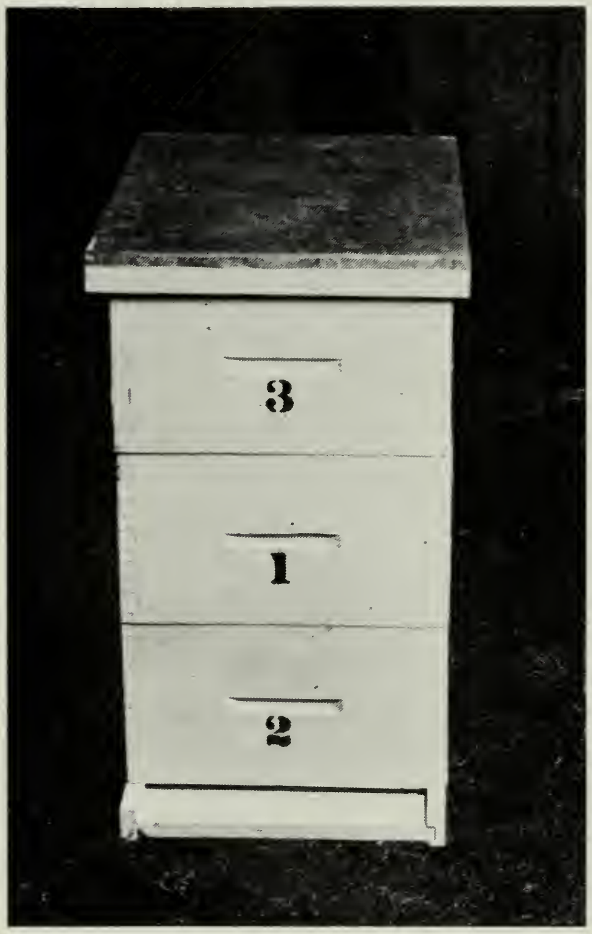


Fig. 13. Third set of combs added to brood chamber.

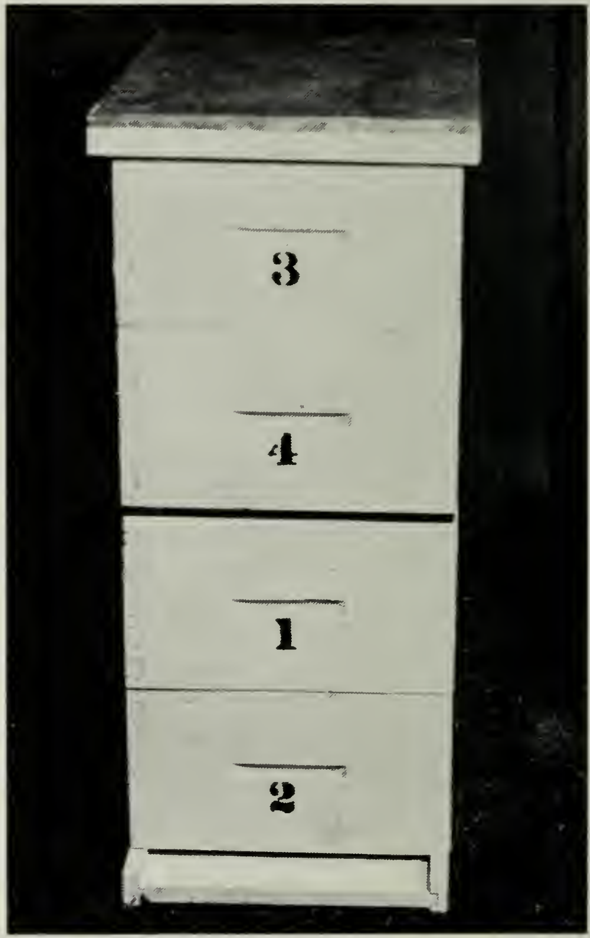


Fig. 14. Number 3 super raised up and Number 4 super added next to queen-excluder. Number 4 super being placed directly above excluder helps relieve congestion of brood chamber (see text) during honey flow.

must be thoroughly examined for others and the necessary destruction of cells carried out. When it seems necessary to add the third set of combs for storage without increasing the size of the brood nest beyond a double brood chamber, a queen-excluder may be used in between the second and third hive bodies.

It is very seldom that any manipulations other than those mentioned above will be required between May and the commencement of the main honey flow, which usually starts during the latter part of June. Just about the time this main honey flow begins one or two supers of storage comb should be given to each colony, depending upon the strength of the colony and the usual nature of the flow in that particular area.

SWARM CONTROL

Swarming is the honeybee's natural means of reproduction and perpetuation of the species, but this tendency has been largely bred out of modern strains of bees by proper selection. Little trouble should be encountered if the aforementioned programme is followed. However, some colonies will show a decided inclination to swarm regardless of the preventive measures used against it. In order to control such colonies one or more things may be done. First of all, the old queen could be killed and a new queen introduced in its place after an interval of two or three days. Destroy all the queen cells that may have been started before introducing the new queen. The presence of the young queen along with the interruption of brood rearing created by the killing of the old queen will usually overcome any definite inclination to swarm if the overcrowded conditions of the brood nest and storage areas have been alleviated. Another plan which could be followed would be to leave the old queen with one frame of brood on the old stand, move the brood and adhering bees to a new stand and introduce a new queen. A third method of control which could be used would be to exchange the location of the colony attempting to swarm with that of a weaker one. In this way the strong colony will be depleted in population and thus the swarming tendency overcome, while the weaker unit will have the addition of the extra field force of the stronger colony. This latter procedure should be followed only during ideal weather and nectar-secreting conditions.

SUPERING

The first honey storage super given to a colony may be added on top of that which is already there, or as shown in the diagram where it is placed beneath the previously added super. However, if any further supers are added they should be placed on top to avoid the unnecessary lifting of heavy supers which have to be replaced after new ones have been added to the colony. This top supering is made possible when colonies are operated in a double brood chamber, so that it is hardly necessary to examine the brood chambers during the period of the main honey flow from the first to latter part of July. During the early part of the honey flow colonies should always have at least half a super empty for future storage. As the honey flow tapers off supers should be added very carefully so that no more than the required amount of storage space is available to the bees. This will encourage them to completely fill the corners of any frames that may not have already been filled to capacity.

REMOVING THE CROP

As soon as the combs have been three-quarters capped they are ready to be removed. Bees may be removed from the honey supers by the use of a bee-escape board or simply by brushing and shaking the bees from the individual combs. This latter method is perhaps not the best for a beginner as the bees do not take kindly to the rough treatment and sting vigorously. It usually takes 24 to 48 hours to remove the bees from two supers placed above a bee-escape board. The bee-escape permits the bees to pass down through a 1-inch hole and then directs them on the underside through a ¼-inch opening. Not more than 2 supers should be placed on an escape board at one time. Since honeybees are prone to rob when no nectar is available from the fields, care should be taken to see that there is no crack or crevice above the escape board through which bees may gain entrance to steal the honey.

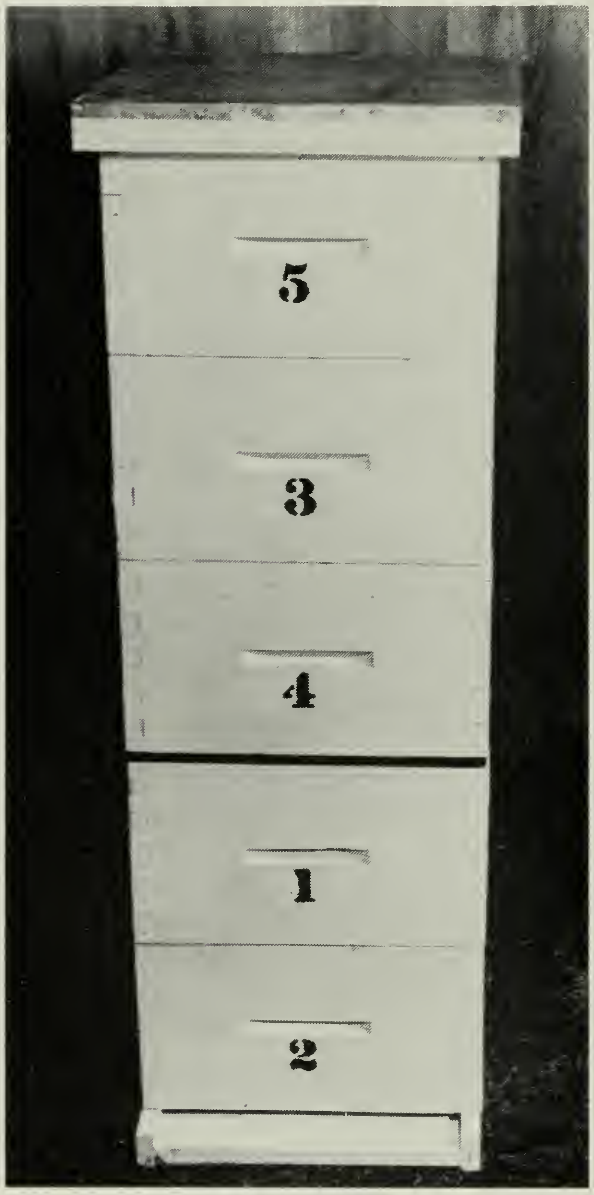


Fig. 15. A third honey storage super Number 5 added on top.

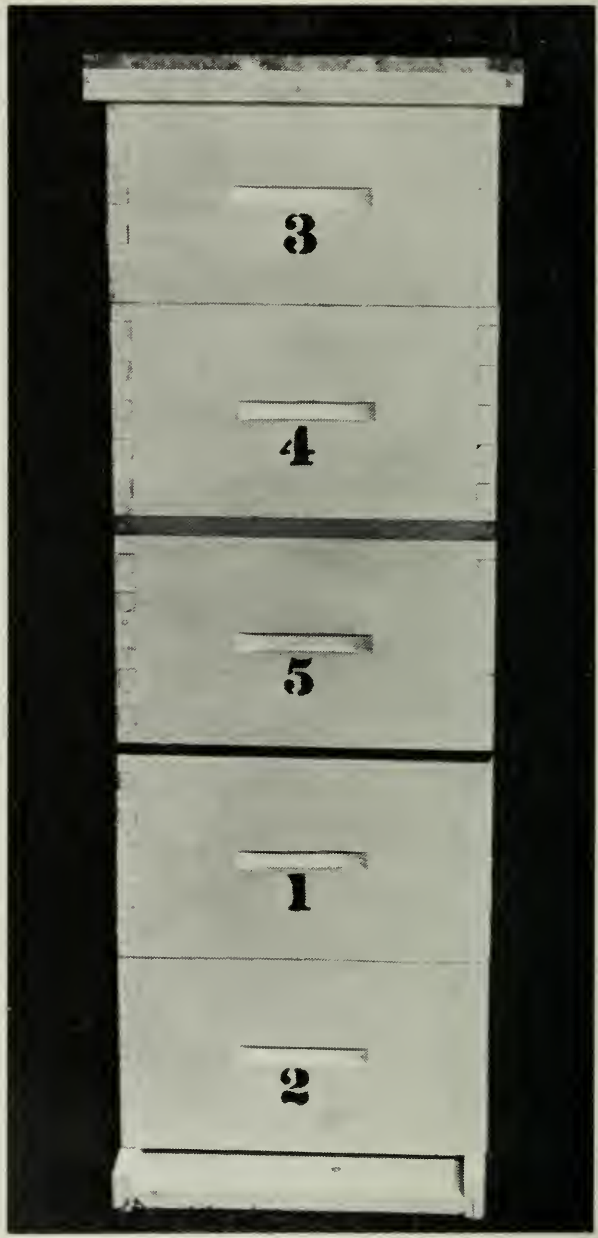


Fig. 16. Supers 3 and 4 ready for removal and placed above a bee-escape board on top of the last super Number 5.

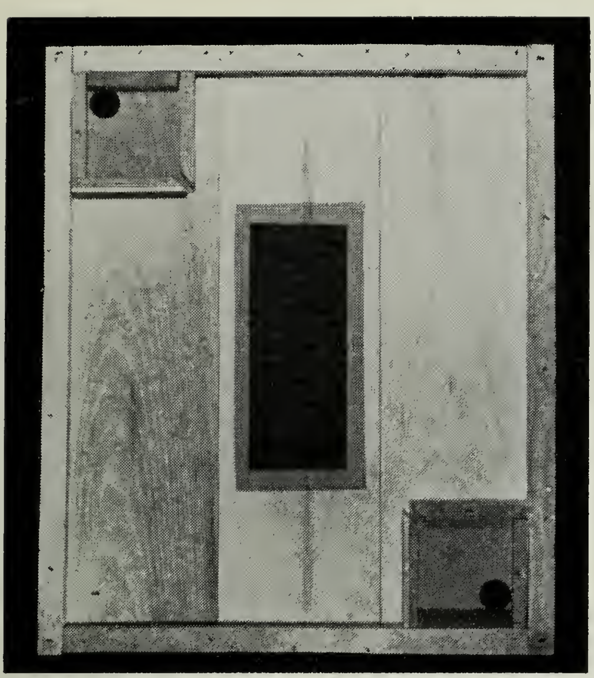


Fig. 17. Homemade bee-escape board. Bottom view.

Many commercial beekeepers drive the bees out of the honey supers with carbolic acid fumes. A board similar to a hive cover but lined with cloth on the lower surface is used for this purpose. The cloth side is dampened with carbolic acid and placed directly above the honey supers. Carbolic acid boards work best on sunny days. The upper surface of the board should be painted black to absorb a maximum of heat from the sun. This causes fumes to be given off rapidly from the moistened cloth and drives the bees down from the honey supers. Under favourable conditions this should take from three to five minutes. Carbolic boards should not be left in position longer than ten minutes. It is important to use only pure carbolic crystals, otherwise the honey may be tainted. Pure crystals are available through bee supply dealers. To prepare the crystals for use they should be melted by placing the container in warm water. Mix 2 tablespoons of water with each pound of melted crystals to keep them in a liquid form.

This system has the advantage that only one trip to the apiary is necessary to remove the honey supers. When the combs have been extracted they may be replaced on the colonies if a second honey flow is anticipated from crops such as buckwheat or second growth of alfalfa and red clover.

FALL MANAGEMENT

During the early part of August each colony should have a young queen or be given one so that it will go into winter quarters with a good population of young bees, a vigorous queen and a plentiful supply of feed. Good honey is the best winter feed for bees and may be left on the colony at the time the crop is removed. If it is not the policy of the beekeeper to feed honey for wintering, sugar syrup should be supplied to the colony during the latter half of September. About September 15th any extra supers remaining on the colony, regardless of whether they have honey in them or not, should be removed and the colony arranged in preparation for winter packing.

Most colonies will cease to rear new brood about the latter part of September or early October, and all the brood present will have hatched by October 20th or thereabouts. For successful wintering in order to have a productive colony the following season there should be the young queen and aforementioned population of young bees and at least 60 pounds of honey plus whatever pollen is stored in the brood nest. One filled super contains about 60 pounds of honey. A good colony for winter will have bees covering 8 to 10 frames on a cool morning when they are slightly clustered. When the temperature goes

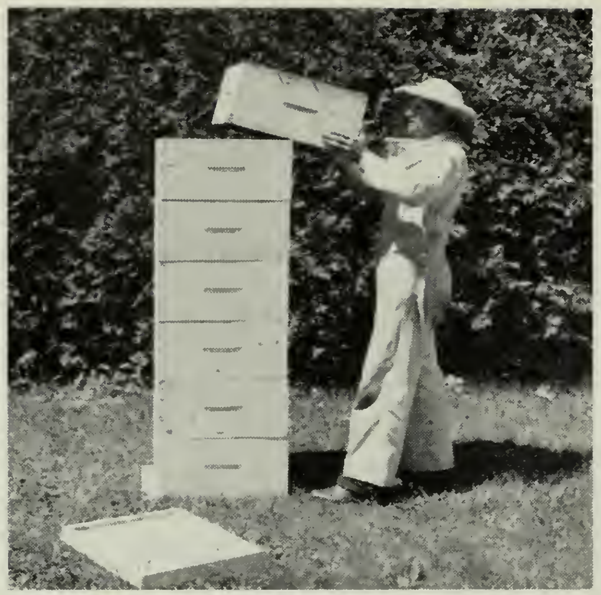


Fig. 18

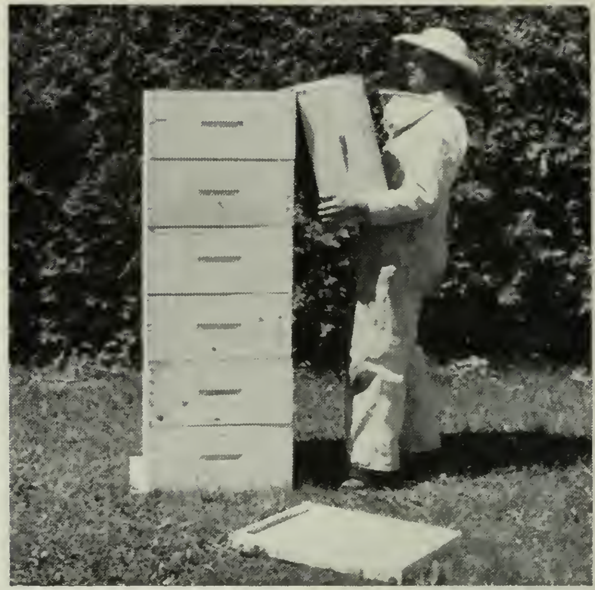


Fig. 19

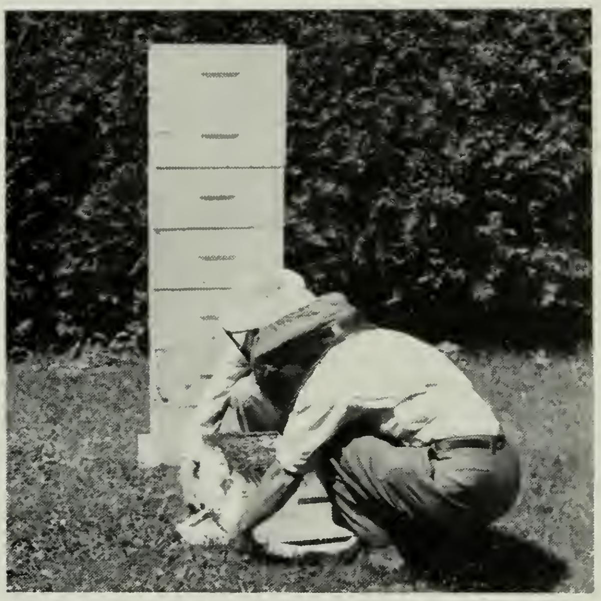


Fig. 20

Fig. 18 and Fig. 19. One person removing heavy super.

Fig. 20, Fig. 21 and Fig. 22. Two persons replacing heavy super at top of high colony. This is a difficult task when attempted alone.

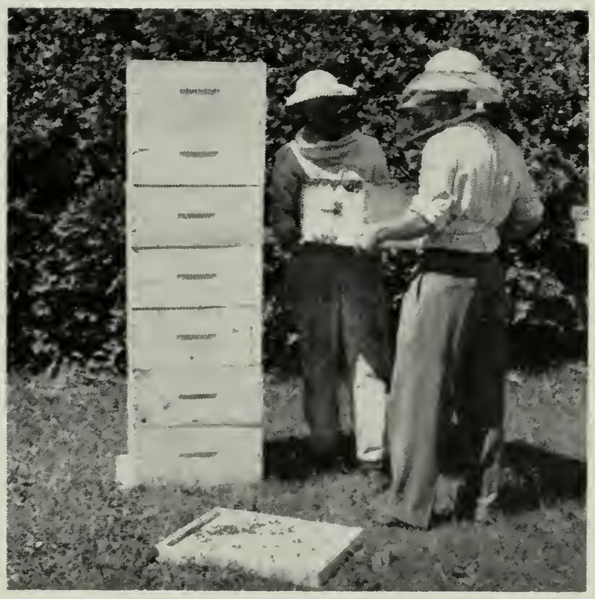


Fig. 21

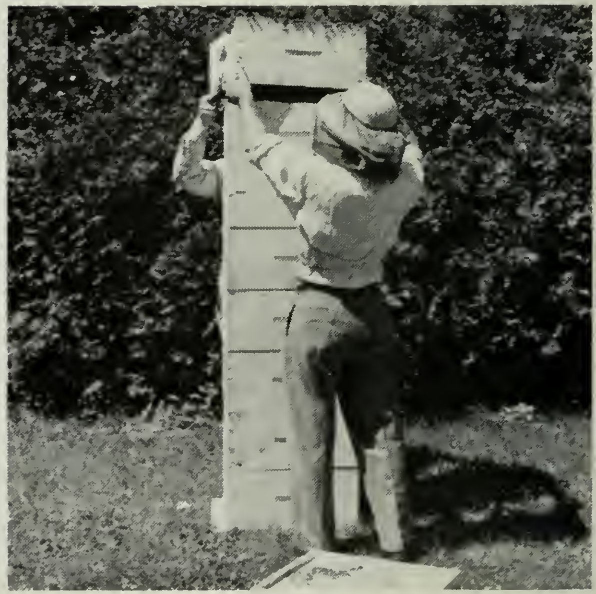


Fig. 22

down to 57° F. honeybees move together to form a cluster for mutual protection. Individual bees cannot survive temperatures much below 45° F. but when numbers of them cluster they are able to survive temperatures well below zero and even raise brood under winter conditions. Spring brood rearing usually starts in February or March. The cluster temperatures will range from 43° F. on the outside to as high as 95° F. in the centre if an incubation temperature is necessary. About 65° F. is the average temperature for the centre of the cluster when no brood is present. Such heat is created by food consumption and muscular activity. The lower the outside temperature becomes the greater is the inside activity.

WINTER PACKING

Honeybees should have some form of protection during the winter to help them withstand sudden changes of temperature and cold winds. Insulation provided for this purpose helps conserve the energy of the bees and the food supply. Winter packing may be done during the latter half of October when it is warm enough to work comfortably but not warm enough for the bees to fly. A simple and effective means of winter protection is by the method illustrated.

For packing, Number 2 asphalt sheathing paper is recommended. Planer shavings, leaves or straw may be used for insulation. Other materials consist of an inner cover which supplies a top entrance, a strip of wood to form a bridge at the lower entrance and entrance blocks. Binder twine or other strong cord is used to hold the cover.

A roll of paper is usually about 1,600 inches long, and when cut into 95-inch lengths will pack 16 colonies. This gives 2 inches of insulation and allows for 5¾-inch lap. The lap joint may be sealed with asphalt pitch for asphalt sheathing, where many colonies are operated, or by using three or four nails to fasten the ends together where only a few colonies are to be packed. The entrance block for the top entrance has a ¾-inch hole; the lower opening is 3″ x ⅜.″ The paper is just pierced through these entrance allowances as each colony will open the paper to suit its own requirements. About 4 to 6 inches of insulation must be provided on top of the colonies.

Colonies packed in asphalt paper must be fenced from livestock, as they may tear the paper.

The packing form shown gives a neatly finished job and is made to give 2 inches of packing. It is hinged on three corners so it may be folded flat, and is hooked at the fourth corner.

The top entrance is advantageous where snow is usually deep, or where icing at the entrance is encountered, and gives a readily accessible entrance as the cluster of bees is usually near the top of the hive in late winter and early spring. A ¾-inch hole could be bored into the top super for this purpose in place of a notched inner cover.

At the present time there is a tendency to wrap colonies with the black paper without giving any insulation on the sides. Top packing as described above is used. Less paper is required and less time to do the work. However, it is questionable if the wintering results are quite as good as where side packing is used.

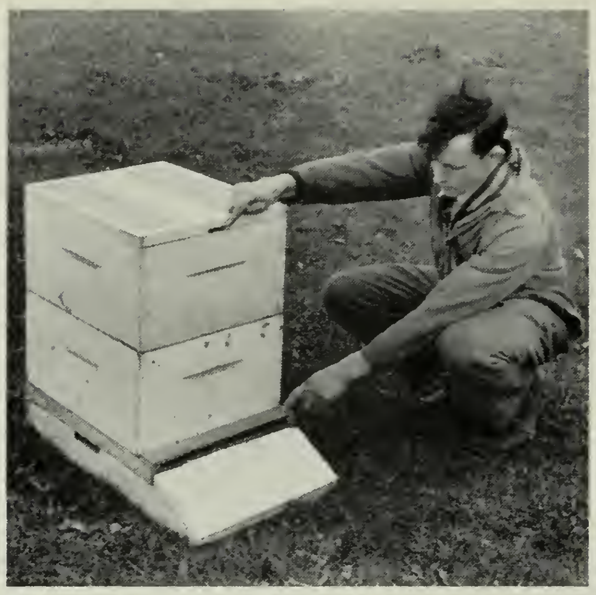


Fig. 23

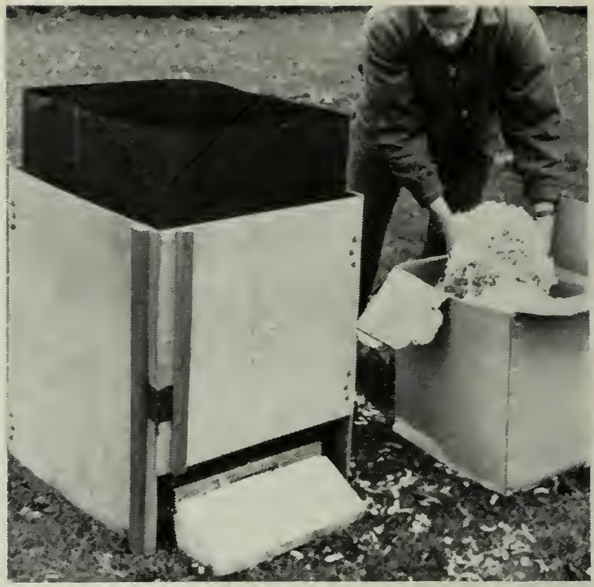


Fig. 24

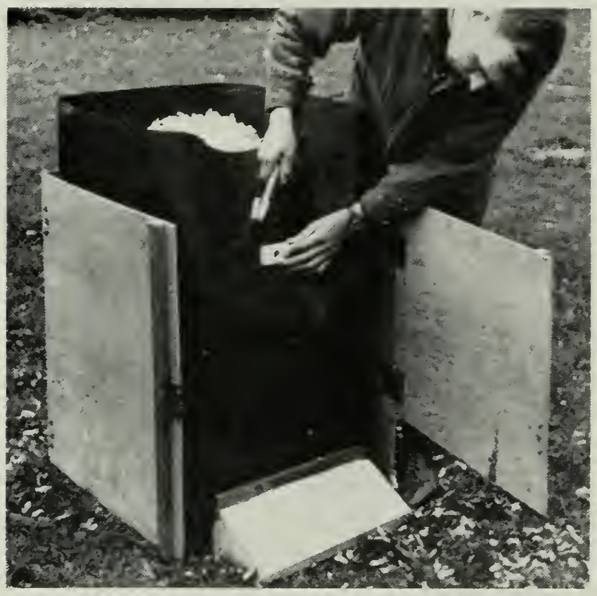


Fig. 25

Fig. 23. Colony prepared for winter packing. Top entrance in rim of inner cover and bottom entrance bridge.

Fig. 24. Paper sleeve and packing form in place.

Fig. 25. Nailing on top entrance block. Bottom entrance block in place.

Fig. 26. Folding in top paper above top packing.

Fig. 27. Packing completed.

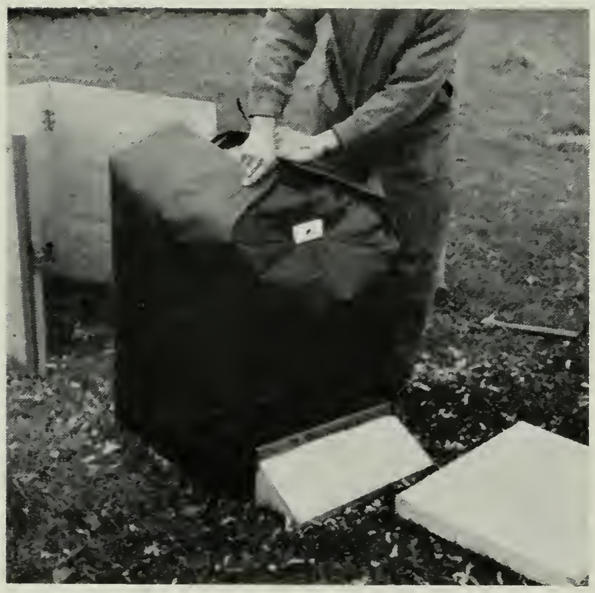


Fig. 26

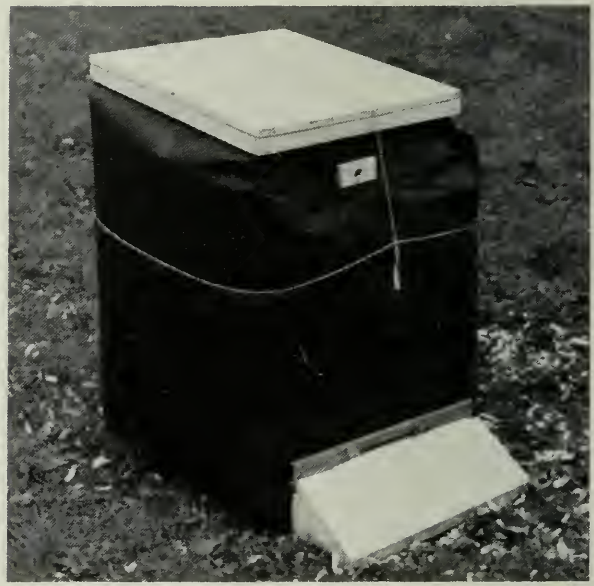


Fig. 27

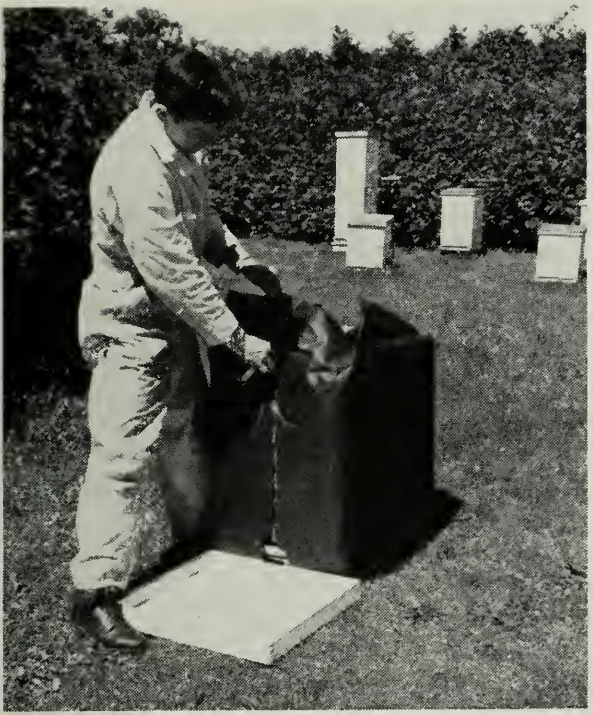


Fig. 28. Cover placed at front to catch front packing material. Hive tool cuts paper. Cut at front as paper already cut there for entrances.

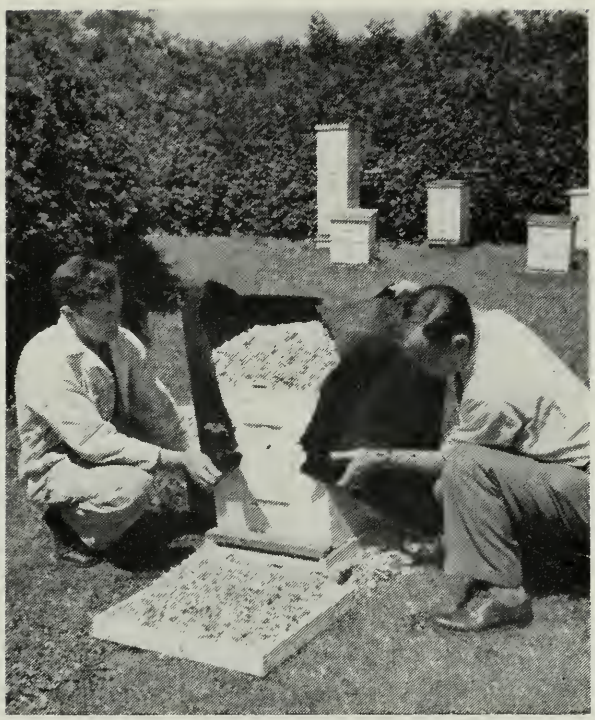


Fig. 29. Throwing paper back to catch side packing by forcing paper against hive. One person may accomplish same by straddling front of hive.

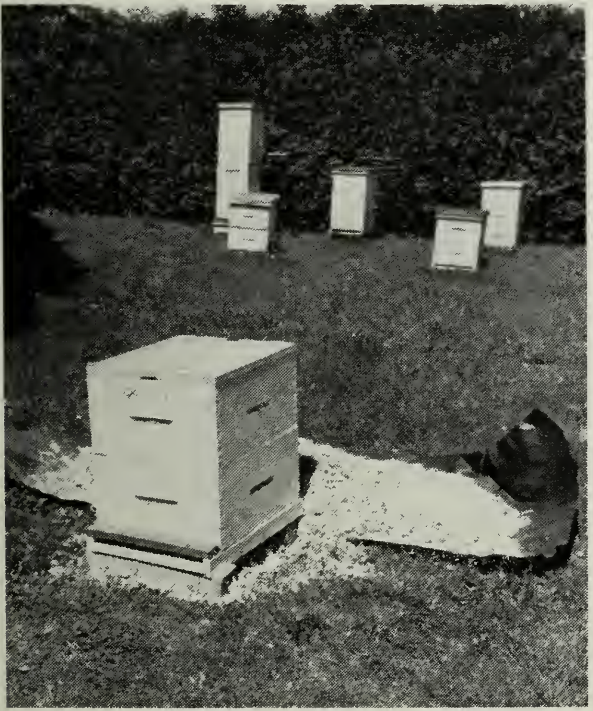


Fig. 30. Packing removed and on paper. Note cement block hive stands.

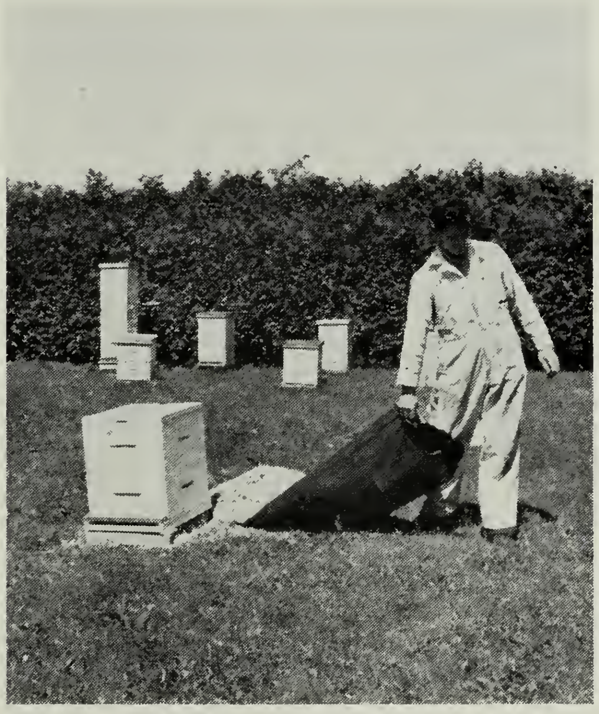


Fig. 31. Dragging paper and packing material away for storage. Paper may be used again by sealing narrow strip down cut edge or lifting paper up off colony without cutting.

Unpacking Colonies Packed in Asphalt Paper.

GUIDE TO SEASONAL MANAGEMENT

The Guide to Seasonal Management chart shows an outline of average population trends for a colony of bees from April to November. The approximate dates for various colony manipulations are given under the population graph and opposite the proper time on the calendar strip. The sequence of blooming dates of the various plants is shown across the bottom of the chart. Colony manipulations under the Demaree and Simplified plans for extracted honey and the Miller plan for comb honey production, are indicated in the same manner.

The systems of management outlined here are two of many in use by both commercial and side-line operators. The Demaree plan is essentially a single brood chamber system. In spite of the fact that much heavy lifting is required to reach the brood chamber during mid-summer, this system is used by many. The Simplified system is a double brood chamber plan and is becoming more popular each year. This is practically the same as the management described elsewhere in this bulletin.

COMB HONEY

For comb honey production the general operation of colonies is exactly the same as with extracted honey production, except that at the beginning of the main honey flow colonies are reduced to a single brood chamber and special comb honey supers instead of extracting supers are used.

In extracted honey production the combs are used over again, whereas new combs must be made each year for section comb honey. The new combs are started from a special thin foundation.

During the build-up period prior to the main honey flow colonies should be requeened with a young queen and stimulated to give the largest possible brood production. At the beginning of the main honey flow reduce to a single brood chamber and place one or two comb honey supers directly above this without using a queen-excluder between them. It will be found necessary to remove some of the brood and use it elsewhere to strengthen weak colonies or make increase. Fill the brood nest with capped brood combs. Management for comb honey is more difficult than that for extracted honey production during the main honey flow because colonies are crowded into less equipment. Swarm prevention thus becomes a greater problem. Comb honey supers must be manipulated in the proper order to make it possible to have fully completed sections that are not travel stained. Add a new super when the previous one is about half full. Crowd the storage area toward the end of the honey flow so the bees will completely cap the sections. Finished sections should be removed by using bee-escape boards.

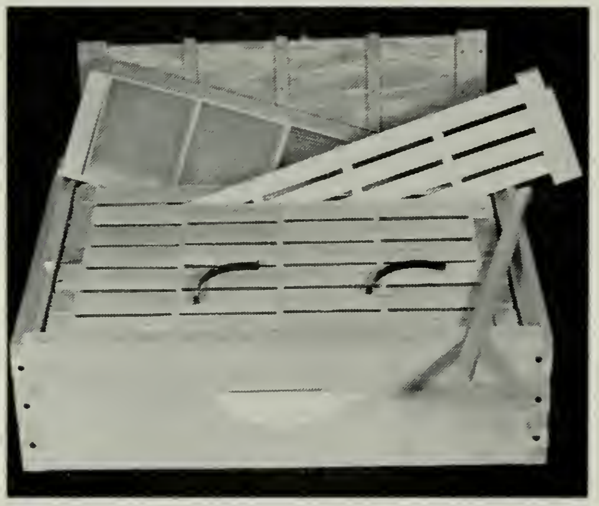


Fig. 32. Comb honey super showing sections with foundation, fence, etc.

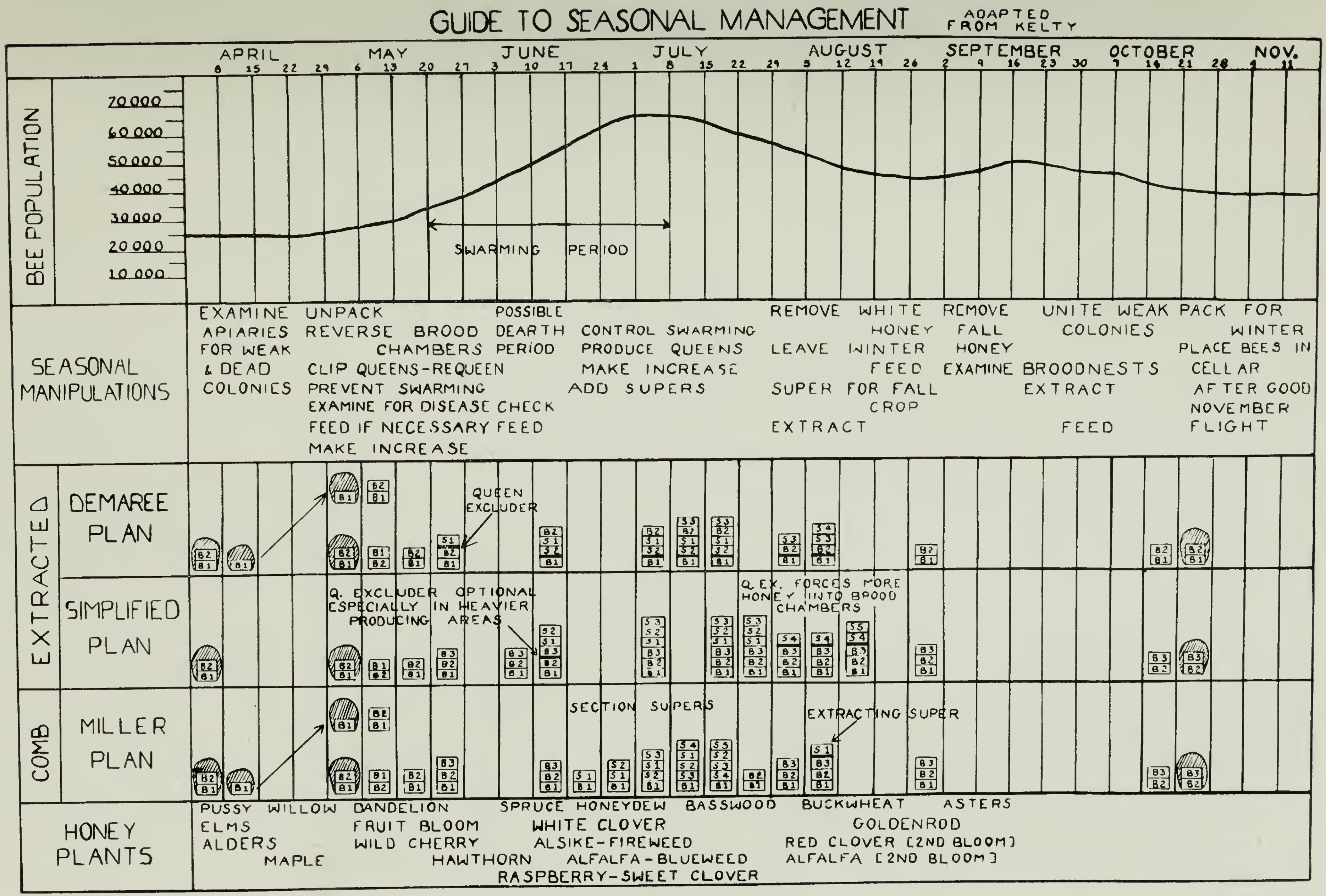


Fig. 33. Guide to Seasonal Management.

The accompanying diagram shows the proper manipulation of supers during a good honey flow.

Chunk comb honey may be easily produced by placing thin foundation in shallow (half depth) or standard depth frames. The filled combs are removed from the hive and then cut into the desired size. These pieces of comb honey are wrapped in cellophane or put into suitable boxes. Super manipulations are the same as for the section comb honey to obtain well filled combs that are not bee travel stained. A limited amount of chunk honey could be produced in conjunction with extracted honey production by using a few frames containing the thin comb foundation.

Comb honey is extremely fragile. Therefore it must be well packed and carefully handled for shipping. Corrugated cartons are available for this purpose.

When preparing for market, the propolis (or bee glue) should be removed from the wood section. Ideal comb honey storage is a dry atmosphere of about 70° to 80° F. Under these conditions it will likely be necessary to fumigate for wax moth. Granulated comb honey is not desirable and therefore sections must be sold while the honey is still liquid. January is usually about the end of the comb honey selling period.

Any unmarketable sections may have the honey removed by extracting or robbing by the bees. These empty sections should be saved and used to encourage the bees to work more readily in the comb honey supers the following season.

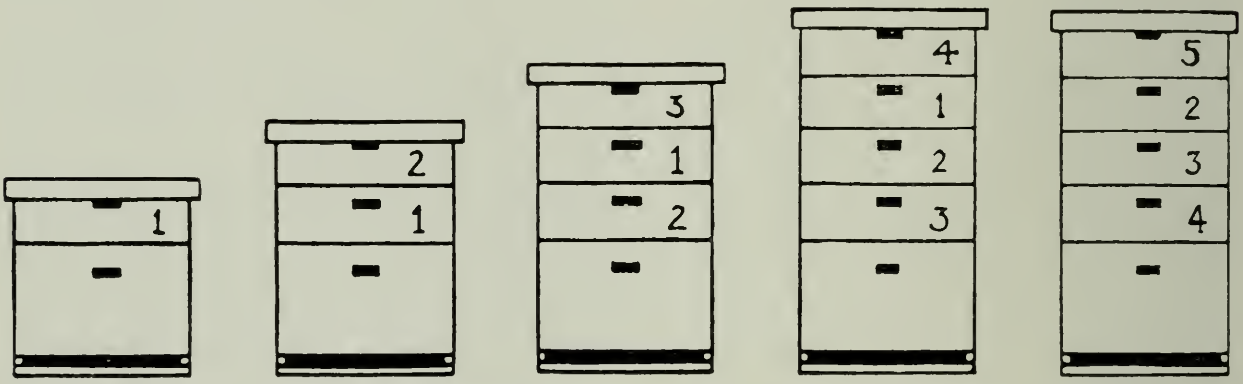


Fig. 34. Supering for comb honey production. Supers are numbered in succession as placed on the colony.

HANDLING SWARMS

Swarms usually appear during times when the bees are able to obtain ample supplies of feed and under crowded hive conditions. The first swarm to issue is called a prime swarm and will have the old queen and about half of the bees of the colony. If the swarming impulse is not checked secondary swarms will follow with virgin queens. Occasionally under supersedure conditions a swarm will accompany a queen on a mating flight.

Most swarms issue during mid-day and cluster on some convenient object within a few feet of their hive. This is to be sure the queen is with the swarm.

In a few minutes to several hours the swarm will again take flight and travel to their final nest that has supposedly been chosen by scout bees.

During the initial excitement of swarming the bees are very easy to handle. If they have settled on a low branch of a tree it is an easy matter to cut this branch and carry the swarm to a hive prepared for them. Allow the bees to run in from in front. It is preferable to start mainly with foundation in this hive and then give more drawn combs when the swarm has settled down.

If a swarm settles on a post or some other awkward object it is more difficult to handle and must be brushed off its resting place. Some swarms will settle on a limb of a tree that cannot be cut but from which the bees can be shaken loose. Place under them a hive body of frames, with foundation or combs, but with the cover off, and give the branch sufficient jar to dislodge the bees and most of them should land in or near the prepared hive. If the queen is in the new hive the whole swarm will be there in a few minutes. Watch to see that the queen is not lost in the adjoining grass. Swarms that alight on the top of a high tree or building sometimes have to be abandoned.

When it is known from which colony a swarm has come it is sometimes possible to put it back into the parent hive. All queen cells must be destroyed so that no more swarming could take place for at least another ten days, and the congested condition relieved.

Hiving a Swarm with Clipped Queen

Some beekeepers clip the wings of their queens to prevent them flying and leaving with a swarm. By clipping the right wing of all new queens introduced one year and the left wing of those used the following year, it is possible to have a check on the age of your queens. Wing clipping also shows whether or not colonies have superseded.

Any queen that has been clipped will go only two or three feet from the hive in an attempt to swarm. The bees will return and leave with the first virgin queen that emerges. While wing clipping does slow down the swarming, it does not stop it.

Locate the queen on the ground near the hive and place her in a queen cage until the swarm returns. In the interval before the swarm returns remove the hive from which the swarm came and place a hive body containing foundation or drawn comb on the hive stand. Above this, place a queen-excluder, one or two supers and the brood chambers of the original colony. When the swarm has returned the queen could be released by allowing her to run in the entrance. If an increase should be desired the brood and adhering bees could be placed on another stand.

MAKING INCREASE

Increasing the number of colonies may be done by purchasing established colonies, buying package bees, or by dividing already established colonies. The latter method is perhaps the most inexpensive but is usually the slowest.

As far as the beginner is concerned, the best time to divide colonies or make nuclei is about May 15th. This gives the small colony (nucleus) most of the season in which to build up in strength to be in proper condition for wintering.

The making of increase usually appreciably reduces the surplus crop during the season when the increase is made. However, there will be little reduction in the crop by starting the increase on the same stand as the parent colony. Queens are ordered for arrival between May 10th and 20th, and the increase is made by drawing 3 to 6 combs of brood and bees from a very strong colony. Replace these brood combs with other empty comb. On top of the original brood chamber place a double screened board or a bee-escape board with the bee-escape closed. Cut a small opening in the rim of this board to give an entrance for the new colony which will be placed above this instead of on a new stand. Introduce the queen and place the original hive cover on top. Be sure both parts have sufficient feed.

The double colony thus obtained is operated in this manner until about the first week of the honey flow. Then the increase is moved off to a new stand. The field bees from the increase will return to the original stand and increase the field force, thus increasing the gathering potential of the parent colony.

Nuclei may also be made up from very strong colonies by taking two, three or four combs of emerging or capped brood and the adhering bees and placing them in a new hive body on a new stand. If this is done during flying weather about mid-day there will be fewer bees returning to the old hive. In order to be sure enough bees are in the nucleus shake in the bees from two or three more combs. Before removing any combs from the colony locate the queen and place her and the comb she is on outside the hive to be sure the parent colony is not deprived of its queen. The equivalent of one or two combs of honey must be included, depending on the amount of nectar available. Introduce a queen by the usual method and leave for at least a week. A queen cell ready to hatch may be used for this purpose instead of a queen, but the progress of the new colony will be very slow. A reduced crop may be expected from the original colony when taking increase from it this way.

Very good increase may be made by moving medium strength colonies to a new location about July 1st and dividing into two fairly equal parts and giving a queen to the queenless portion. Most seasons this type of increase will store sufficient winter feed or even give a surplus.

PACKAGE BEES

Colonies in the Southern States are able to produce a surplus of bees when those in Canada are still going through the spring build-up period. This makes possible the shipping of young bees into Canada during the months of April and May to start new colonies or build up the ones that were weakened during the winter.

Many beekeepers buy 2-pound packages, but 3-, 4- and 5-pound packages may also be obtained. The 2-pound package contains about 10,000 bees. Some seasons this number is capable of building up a colony rapidly enough to gather a surplus the first year. The bulk of the packages are shipped with one untested queen, but queenless packages may be obtained for strengthening weak colonies. A queenless package added to a weak colony at the right time may mean a strong colony in time for the honey flow.

Ordering

Under normal circumstances it is well to order packages a month or more before the date the bees should arrive, as the package producer may be rushed with work, and late orders will be delayed. Names of producers may be obtained from advertisements in any of the bee journals. When ordering, state the date on which the bees should arrive. Late April or early May is considered the best time to install package bees in Ontario.

Care Upon Arrival

A day or two before the packages arrive it is well to prepare the hives which are to receive them. If no drawn combs are available, foundation may be used just as satisfactorily, providing the bees are given plenty of syrup and if pollen is available in the field. Upon arrival the packages should be put in a dark, cool place. It is a good plan to sprinkle some sugar syrup on the outside of the cages. The bees will fill themselves with this syrup and cluster quietly together.

Introduction to the Hive

Frequent supersedure of the queen is one of the chief drawbacks of package bees, and proper care in introduction will eliminate a great deal of the trouble. There are several methods used, and no one of them can be described as best. In many cases the method is limited by the facilities at hand. The queen is the most important individual and care must be taken to see that she is not chilled during introduction. It is best to install the bees on a cool, dull day or else in the evening. This prevents the bees from doing much flying and consequently drifting to other hives.

When everything is ready set a package out beside each hive. Open the package and place it in the hive beside 5 combs, with the opening facing upwards. Remove the syrup can and the queen cage. If the bees are clustered tightly around the queen cage it may be necessary to give the package a slight jar on the ground to remove the bees from the cage. Tear off the strip of paper covering one end of the queen cage. If there is candy in the cage it is usually considered advisable to press a match or small nail through it so the bees can more readily release the queen. Then suspend the cage between the frames. All these manipulations should be done as quickly as possible. It is well to supply the colony with at least one 10-pound pail of syrup; 2 pails of syrup should be given if the bees are installed on foundation. Some consider it advisable to feed warm syrup, as the bees will take it down more readily. Place an empty super on top, wrap a sack around the feeder pail for insulation and close up the hive with a lid. The entrance should be reduced to about ½ inch, the opening being left in the side containing the combs. One day later quietly remove the empty package and queen cage and supply the full complement of combs. To confine the bees to the lower hive body and conserve heat it is advisable to place above the combs a sheet of tarpaper with a hole cut for the feeder pail.

An alternative method of installing package bees is to remove a side of the cage after the bees have been soaked with warm water to prevent them from being too active and shake them directly into the hive. If the weather is cold the water should be used sparingly. All the combs may be added immediately.

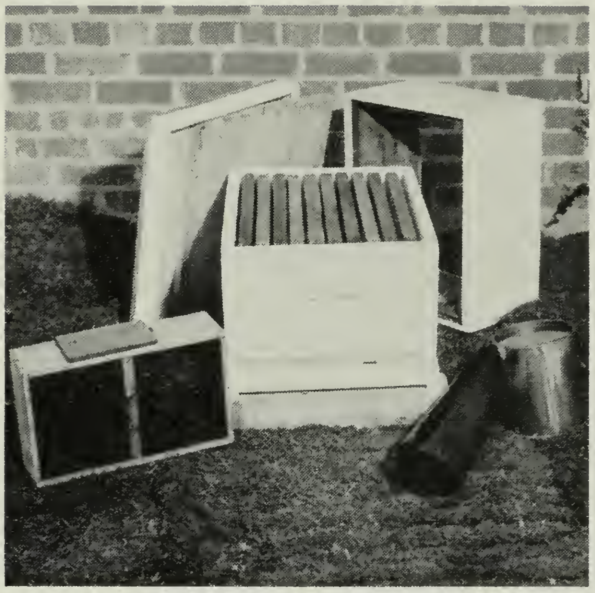


Fig. 35. Ready to install the package.

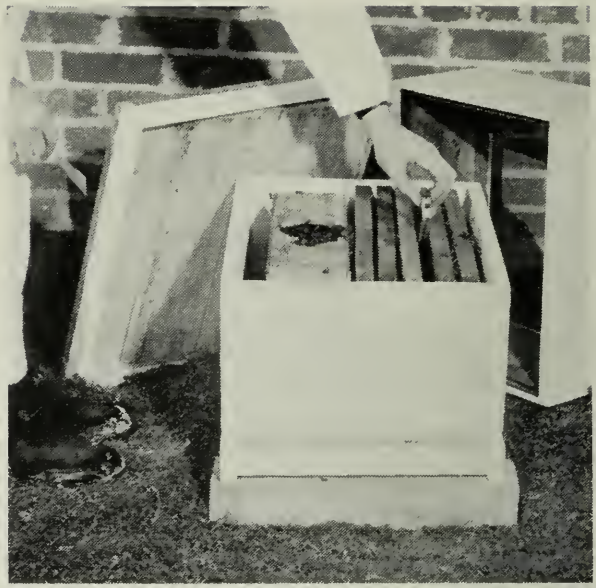


Fig. 36. Suspending queen cage between combs with package in place.

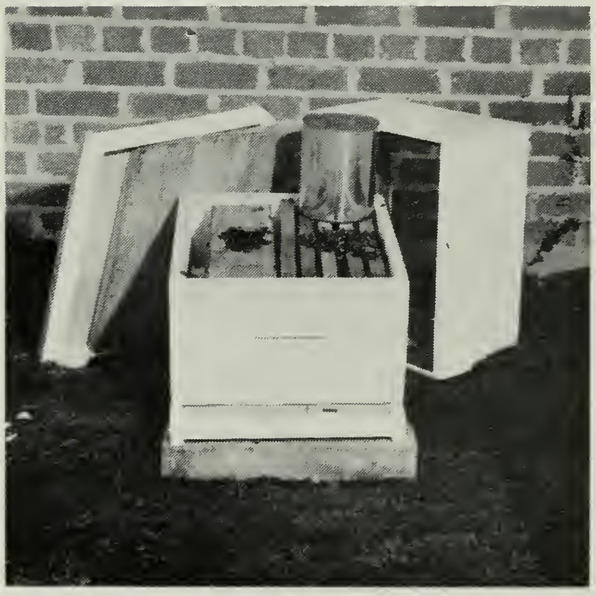


Fig. 37. Package and syrup in place.

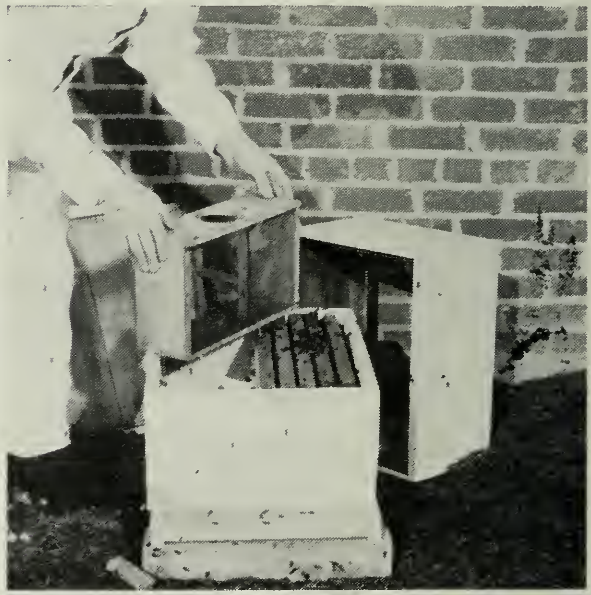


Fig. 38. Removing the empty package one day later.

Introducing Package Bees.

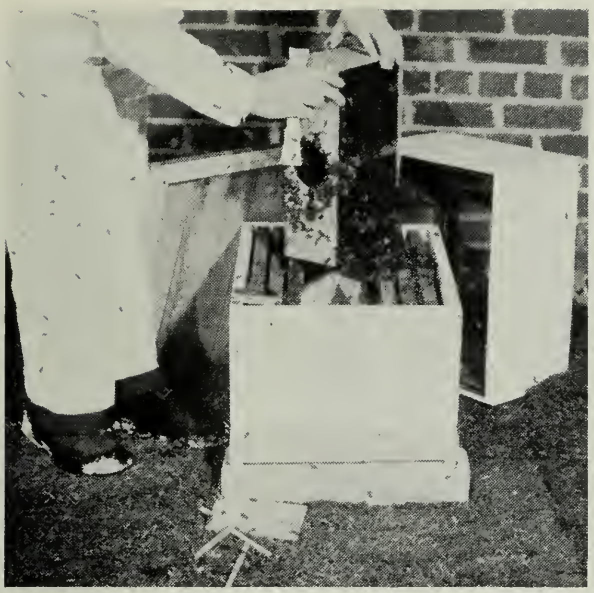


Fig. 39. An alternative method of installation — removing the screen on the side of the package and shaking bees out.

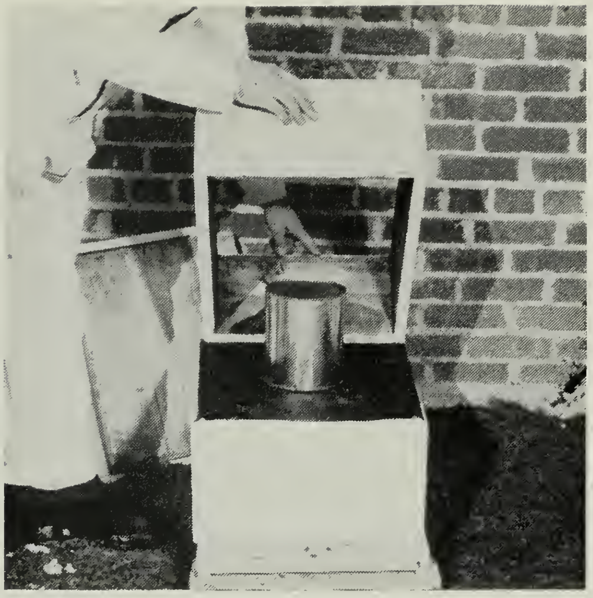


Fig. 40. Full complement of combs added and syrup in place over tarpaper.

The queen is released between the combs and will begin to lay within a very short time. Warm syrup is supplied and the hive left for about a week without disturbing. Curiosity to see how the bees are getting along is the cause of much queen supersedure. The bees will make greater headway if they are left for at least a week without any disturbance.

Unless the bees are able to gather nectar from the plants it is very important to keep them well supplied with sugar syrup. Pollen is also essential for the rearing of brood, and is frequently a limiting factor in the progress of the colony. In most sections of the Province pollen is plentiful in the spring. A frame or two containing pollen, however, is very necessary in districts where pollen is scarce.

In Southern Ontario it is preferable to pack colonies for winter and use packages to replace winter loss or make increase. The high rate of supersedure in recent years has made the practice of purchasing packages often very unprofitable.

FEEDING OF BEES

The cheapest and most efficient method of feeding bees is to leave a super of good honey from the previous crop on each colony. However in some seasons the quality of the honey is poor or the quantity is insufficient; in either case the food supply must be supplemented with sugar syrup. Bees wintered with top entrances usually obtain more flights during the winter months, which helps them to rid themselves of excess waste materials accumulated as a result of poor winter stores. Nevertheless poor quality feed is hard on over-wintering bees. Honey gathered early in the season may granulate before fall, while late fall honey may on occasion be high in water or dextrin content. These honeys do not make good winter feed and should be avoided in so far as possible.

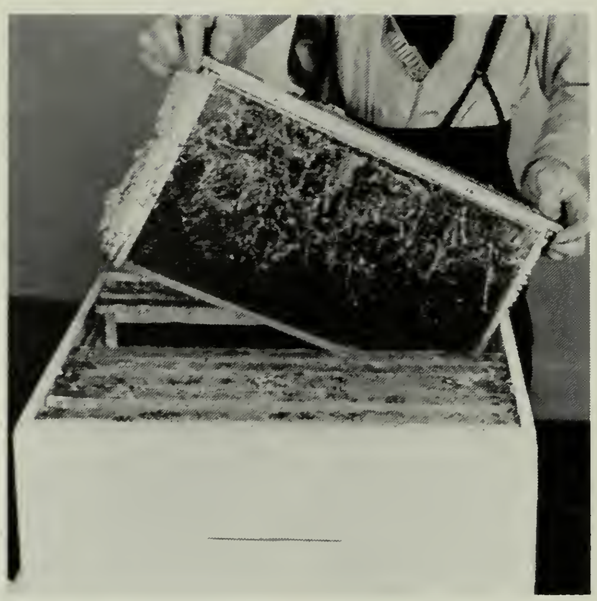


Fig. 41. Avoid comb destruction caused by wax moth. See Bulletin 429, "Bee Diseases and Pests of the Apiary."

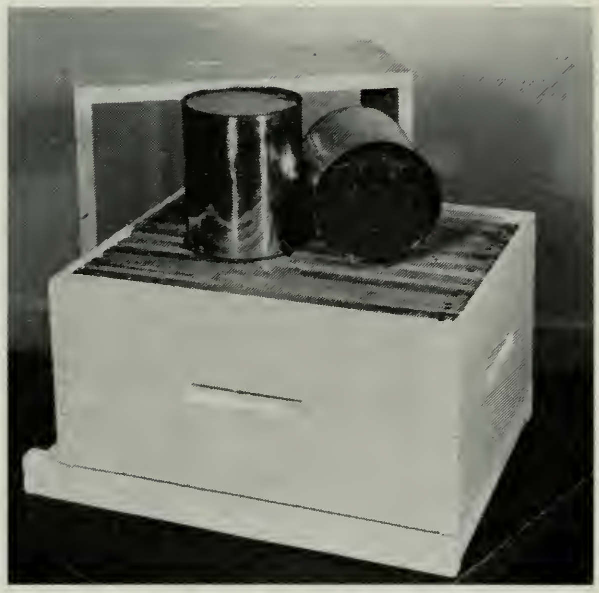


Fig. 42. Friction top feeder pails showing perforations.

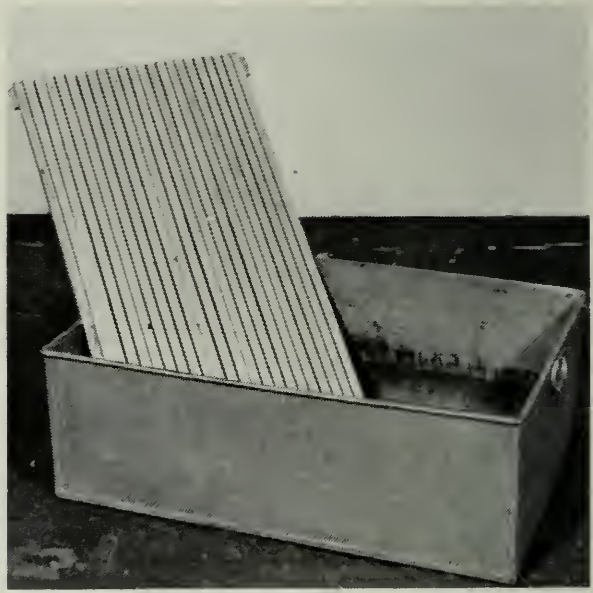


Fig. 43. Open feeder with wooden float.

Fall Feeding

For fall feeding, a heavy syrup made of two parts sugar to one of water is used. This reduces the bees' labour of removing excess water from the syrup late in the fall. Warm syrup fed all at one time is preferable as the bees will take it down more rapidly. This is less likely to stimulate the bees into late brood rearing. It must be remembered that the more work the bees do in the fall the weaker will be the spring cluster. Feeding should be done between September 15th and October 15th.

Syrup for bee feed is easy to make by stirring granulated sugar into hot water. Care must be taken not to scorch the syrup.

Spring Feeding

Spring feeding should be resorted to only to prevent starvation when sufficient feed was not provided in the fall. If it is necessary to feed while the weather is cold the best method is to fill three or four combs with a heavy sugar syrup and place these in the colony in direct contact with the bees. For filling the combs use a sprinkling can or a 2-pound honey pail with the bottom perforated with nail holes. Hold the combs on a 10- to 20-degree slope over a flat pan or tub and pour syrup into the open cells commencing at the high end. When both sides are filled in this manner, a comb will carry about 3 pounds of syrup. Two parts of sugar to one part of water makes a suitable syrup for comb feeding. However, when the weather is warm enough to permit the cluster to break or the bees to fly it is best to use feeder pails or open feeders supplied with a lighter syrup made of equal parts sugar and water.

Types of Feeders

Many types of feeders are used, but the ordinary friction top pail is the most popular. A few nail holes in the lid permit the bees to remove the syrup. Care should be taken to avoid leaky lids or the syrup will escape too rapidly and be wasted or start the bees robbing.

Open feeders are sometimes used for spring feeding. This permits feeding a number of colonies with a minimum of labour, since individual colonies do not have to be opened. Troughs or tubs of syrup equipped with floats to prevent the bees from drowning are simply set out in the bee yard. Wooden racks, straw, or corn cobs make satisfactory floats.

UNITING

Weak or queenless colonies are of little or no value by themselves and should be united in an effort to obtain productive colonies. Two or three poor colonies may be combined into one, or each may be added to a normal queenright unit. Weak colonies in the fall are hardly worth saving and are better destroyed with cyanogas or shaken out onto the grass.

Colonies may be united in cool weather when the bees are clustered simply by placing one colony directly above the other. In most instances, however, certain precautions will have to be taken to prevent the groups of strange bees from fighting. Queenright colonies should be separated by several layers of newspaper and a queen-excluder. Place the brood nest of the stronger colony immediately above the excluder. Pierce the paper in several places to start the bees gnawing through it. By the time both groups of bees have worked through the paper they will be successfully united. Within several days or a week only one queen will be present, and the excluder may be removed. The same procedure is followed when uniting a queenless and a queenright colony, except that the queenright colony should always be placed on top.

Bring the colony with the smaller population of bees to the location of the stronger one. This will result in less drifting of field bees and will conserve the strength of the newly formed unit.

TRANSFERRING BEES

The term transferring, as used by beekeepers, refers to the moving of a colony of bees from a box or non-movable frame hive to a standard type, movable frame hive. If the combs are not removable, the owner, or Inspector, cannot examine the brood for the presence of disease. A single diseased box-hive has been known to spread infection and destroy many colonies in surrounding apiaries in a single season. For this reason the keeping of bees in box-hives in Ontario is illegal, as outlined in The Bees Act. The best time to transfer bees is in the spring of the year during the honey flow, preferably just before swarming time. If necessary, however, transferring can be done at any time during the active season.

The self-transfer method is easy to carry out. During the building-up period before the swarming season invert the box-hive and place a standard hive with drawn comb or foundation directly on top of it. It is advisable to invert the box-hive because the comb is usually attached to the top and will be broken if the top is removed. Quite frequently the box-hive and standard hive are of different dimensions and do not fit tightly together, in which case it is necessary to make them fit, so the bees cannot escape between the two boxes. In a few days the queen will usually be found laying eggs on the movable combs. When examining for the queen, it is a good plan to place an excluder between the two hive bodies before disturbing the bees, or the queen is likely to run below. If the queen is not in the upper hive, she should be found and placed above the excluder. An entrance is then provided to the new hive by putting thin wedges under one end at both sides and the old entrance is closed up.

In 21 days all the worker brood in the box-hive will have emerged. A bee-escape is now placed between the boxes so the bees can get into the top box but cannot return. Two days later the box-hive will normally be empty and can be removed.

Transferring from Buildings, Trees, etc.

First close up all flight holes except one. A day or two later build a platform near this hole large enough to hold a hive, and fix a bee-escape over the hole so the bees can leave their nest but not return. A cone of wire screen about 6 inches long with an opening ¼″ to ⅜″ in diameter at the apex will serve as a bee-escape. A nucleus consisting of two or three frames of capped brood and bees with a queen or ripe queen cell in a standard hive body is then placed on the platform. When the bees returning from the field find they cannot go into their usual entrance they will enter the new hive prepared for them. In about a month all the bees will be in the hive and their old queen will eventually die. At the end of the honey flow the escape may be removed and the bees will then enter the cavity and rob the honey from the old combs. If the colony in the cavity was a large one, considerable honey could be obtained, so the beekeeper should provide additional super room. After the honey is removed be sure the entrance to the old nest is closed and made bee-tight.

Destroying Swarms in Unused Buildings, etc.

In many cases it is not convenient or desirable to remove bees from hollow trees or from buildings not occupied by people. If so, the best plan is to inject cyanogas into their nest to destroy them. Cyanogas is a powerful poison sold in powder form at most drug or hardware stores. The fumes are very dangerous to inhale, and the greatest of care should be taken when using it. If possible work when there is no wind or keep to the windward side of the cyanogas. It is always wise for two people to work together when cyanogas is administered in case of an accident. In some situations gasoline or boiling water may be effectively used to destroy bees.

In dwellings which are occupied, 50 per cent D.D.T. powder may be dusted into the entrance on one or two occasions. If the bees are active a small amount of cyanogas could be added to the D.D.T. provided there is no opportunity for the gas to seep into living quarters.

ROBBING

The tendency to collect and carry sweet substances back to the hive is so strong in honey bees that during times when no natural nectar is available they will search for other sources of supply. This often leads them to steal honey from weak colonies, a habit which at times may be very troublesome to the beekeeper. Disease in most cases is spread through robbing. Once robbing has started it is very difficult to control, therefore it is well to take precautions to prevent this trouble from arising.

Should it be necessary to examine colonies at a time when robbing is likely to occur, such as just after a honey flow, work rapidly and do not keep colonies open any longer than necessary. If robbing commences, postpone operations until a more favourable time. The opportunity for robber bees to gain entrance to other colonies may be considerably lessened by reducing hive entrances and making certain that hive covers and supers are bee-tight. Do not leave honey supers exposed, as this is a common starting point for robbing. Combs that have been extracted, but are still wet with honey, are often exposed for the bees to rob, and this practice may cause later trouble. Do not place supers of wet combs near any one colony, or it may be attacked and robbed after the supers are dry.

If a weak colony is being overpowered by robbers it may sometimes be saved by stopping up the entrance with grass. This will prevent robbers from entering and will give the colony a chance to recuperate.

SMALL SCALE QUEEN PRODUCTION

Beekeepers who own only a small number of colonies of bees require some simple but reliable method of queen rearing. The two methods described below will produce good queens without requiring too much labour or skill.

Those wishing to produce queens on a larger scale should use the Doolittle system as described in references 3(a) and (b) herein.

Hopkins Method of Queen Rearing

This method may be employed to secure a large number of queen cells with a minimum expenditure of time and labour. A colony should never be allowed to finish too many cells, as many will probably produce inferior queens.

Procedure

Place an empty brood comb in the centre of the brood nest of the colony from which you wish to breed. At the end of four days the comb is removed. Three out of every four rows of cells are destroyed, both along the length and the width of the comb. This leaves every fourth larva spaced approximately ½ inch apart, for the bees to raise as a queen. There is plenty of space for cells to develop, as well as enough comb so that the ripe cells may be removed without injury.

A cell colony is prepared by removing the queen and causing a hopelessly queenless condition by leaving only sealed brood. For good success the cell colony should be exceptionally strong in bees and well fed. This is provided by either a natural honey flow or by feeding heavy sugar syrup with a feeder. The comb is now laid flat over the middle portion of the brood nest of the prepared colony, with the cells to be drawn facing downward. The comb should be supported by a frame about ½ inch above the brood combs, to give the space for the cells to be drawn. From 20 to 30 good cells may easily be obtained by this method, depending on the strength of the cell colony and the thoroughness of preparation.

Method of Queen Rearing Used by Dr. C. C. Miller

"Into an empty brood frame, at a distance of two or three inches from each end, fasten a starter of foundation about two inches wide at the top, and coming down to a point within an inch or two of the bottom bar. Put it in the hive containing your best queen. To avoid having it filled with drone-comb, take out of the hive, either for a few days or permanently, all but two frames of brood, and put your empty frame between these two. In a week or so you will find this frame half filled with beautiful virgin comb, such as bees delight to use for queen-cells. It will contain young brood with an outer margin of eggs. Trim away with a sharp knife all the outer margin of comb which contains eggs, except, perhaps, a very few eggs next to the youngest brood.

"Now put this prepared frame into the middle of a very strong colony from which the queen has been removed. The bees will do the rest, and you will have as good cells as you can possibly have with any kind of artificial cells. You may think that the bees will start 'wild cells' on their comb. They won't; at least they never do to amount to anything, and, of course, you needn't use those. The soft, new comb with abundant room at the edge, for cells, is so much more to their taste that it has a practical monopoly of all cells started. In about ten days the sealed cells are ready to be cut out and used wherever desired."

REQUEENING

Many beekeepers make it a practice to requeen their colonies regularly. This provides young vigorous queens which are likely to build up more productive colonies, and helps to maintain a desirable stock of bees. Caged queens, ripe queen cells, or queenright nuclei may be used in requeening a colony.

The first step in requeening a colony is to find the old queen and destroy her. If more than one brood chamber is present, lift off the upper one and set it aside on an upturned cover. Use as little smoke as possible so the bees will remain quietly on the combs. Begin searching for the queen in the box containing the most brood. Remove an outside comb and glance along the near side of the next comb and also along the side wall of the hive. Then examine the comb that has been removed by revolving it so the bottom and ends of the frame are not missed. If this fails to reveal the queen, lean the first comb against the outside of the hive, remove the next comb and continue this process until the queen is found. Only the first comb removed is placed outside the hive. After a little practice queens may be found much more quickly by looking over the surface of the comb as a whole instead of examining individual bees.

Once the queen is found and all queen cells removed proceed with requeening. Caged queens are usually shipped along with eight or ten worker attendants in a small wooden cage with a screen top. One end of the cage, containing an escape hole, is filled with sugar candy to serve as feed for the bees while the cage is being shipped. A small strip of cardboard is tacked across the outside of the escape hole. When a caged queen is introduced during a honey flow the cardboard strip could be removed; otherwise it should be left intact.

Place the cage, with the candy end up, between the top bars of two frames near the central part of the brood nest. In due course the bees will eat through the candy and release the queen. For most successful results introduction should be made during a honey flow and the colony should not be disturbed again for at least a week.

When using ripe queen cells for requeening it is advisable to dequeen the colony and destroy any queen cells present a few hours to a day beforehand. Leave a good shoulder on the base of the queen cell that is being used, and attach it to the side of a comb or suspend it between the top bars of two frames.

For requeening with nuclei it may be necessary to use the newspaper method as described under Uniting (see Page 35).

MOVING BEES

Most persons will find it necessary to move bees at some time. The preparation for such a move will depend upon the distance the bees are to be transported and the type of weather to be encountered on the trip. Bees may be moved either with or without screens.

Short Moves

When bees are moved for short distances they will be likely to return to their former location. To overcome this tendency certain precautions must be taken if the colony is not to suffer. Colonies to be moved only a few yards should be changed a few feet at a time on successive days. If the bees are to be moved less than 2 miles they should be moved either in the very early spring or very late fall, at a time when little flight is taking place, or moved 5 to 10 miles and about a month later returned to the new permanent location.

For short trips of only a few miles the boxes and bottom should be fastened together with staples or lath or bound with steel strapping. The bees should be confined by a tuck-in screen at the entrance.

For very short trips with a small number of colonies, where the bees can be completely moved and set down in their new location in the evening before dark, the colonies can be moved without any screening at all.

Long Moves

The moving of bees long distances requires special consideration, especially if the weather is warm. There are two methods by which bees may be moved long distances — either screened or with the entrances open. For moving, a long truck is advisable, and only about 100 colonies should be moved on a load.

Screening: Provision should be made for screening at both the top and bottom of the colony.

The screen at the top should cover the complete colony and allow a clustering space of 2 to 3 inches. Cross supports should be provided to support the cluster above the frames and avoid jarring the cluster from its position. A tuck-in screen should be inserted at the entrance. If the weather is cold the lower entrance may be fastened up tight, using only the upper screen. In hot weather, however, it is necessary to provide both screens.

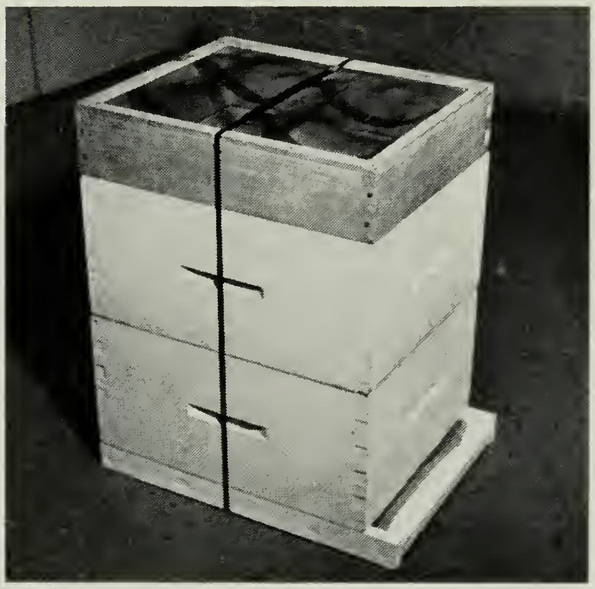


Fig. 44. Colony prepared for moving. Screened top and bottom.

The bees should be stacked on the truck in such a manner that it will allow sufficient ventilation to all colonies. If non-spaced frames are used the colony entrance should face toward the front of the truck, to avoid swaying of the combs. It is advisable to fasten the three centre frames in place by driving nails through the hand holds at each end of the colony. If the heads are allowed to protrude a little, the nails can readily be withdrawn. The weaker colonies should be placed in the centre of the load and the stronger ones on the outside. If the day is hot, with no showers expected, the floor of the truck should be soaked with water and arrangements made for spraying water on the load periodically during the trip. Very little honey should be left on the colonies as in case of over-heating heavy losses of bees may be encountered. If it is necessary to stop for any reason, the motor of the truck should be left running if possible.

Moving Without Screens: Many beekeepers are making their long distance moves without closing the entrances of the colony. This method is especially good during very hot weather and in areas where it is not necessary to pass through large cities.

Loading should start so that the complete load will be on the truck before dark. A puff of smoke should be given to each colony before loading, and several colonies should be left in each section of the yard to catch drifters. These may be placed on the load at the last. It is advisable to keep the truck moving until it reaches its destination. Unloading should be delayed until daybreak.

If the trip lasts more than one day, or if a breakdown is encountered, the truck should be driven or towed before daybreak to a well isolated spot and the balance of the journey delayed until evening. The bees will fly freely and return to the load in the evening.

HONEY

Honey is a sweet, viscid fluid elaborated by bees from the nectar collected from the nectaries of plants, and stored in their nests or hives as food. When nectar is first collected by bees it contains mostly sucrose and may vary all the way from 20 to 60 per cent sugar. While the nectar is being transported from the plant to the hive the bee adds an enzyme called invertase, which breaks down the sucrose, or table sugar, into two simpler sugars. This enzymatic breakdown continues to take place after the honey is stored in the colony. During this period excess moisture is removed by evaporation. When the conversion of the nectar to honey has been completed and it is capped over it consists of the following approximate composition: levulose, 40 per cent; dextrose, 34 per cent; water, 17 per cent; acids, pigments, protein, etc., 5 per cent; sucrose, 2 per cent; and dextrins, 2 per cent.

Honey will pick up considerable moisture if it is stored at a humidity above 60 per cent. This characteristic of honey must be kept in mind at all times when handling the product. Honey must be packed or stored in moisture-proof containers of tin, glass or waxed paper. Even after the honey is capped over it can pick up considerable moisture during a period of high humidity if supers of honey are left over bee-escapes where there are no bees present to keep it dry.

All honeys produced in Canada will granulate. This characteristic makes it rather difficult to hold honey in liquid form. It is for this reason that most of the honey sold in Canada at the present time is marketed in the granulated form. Unless some measure is taken to control the granulation it quite often will be very coarse and will make the product very unattractive.

Heat and aging tend to darken honey and spoil the flavour by caramelizing the levulose. Darker honeys are more sensitive to heat than the whiter honeys. Honey can be brought to quite a high temperature without injury provided it is cooled very rapidly and is not held at this high temperature for any great length of time. Any temperature above 100° F. over a period of time will tend to injure honey.

Honeys each have a characteristic colour and flavour, depending upon the source of the nectar. The whiter and milder flavoured honeys are usually produced from the clovers or basswood, while the darker and stronger flavoured honeys are produced from plants such as buckwheat, golden rod, aster, and some other weeds and wild plants.

Preparation of Honey for Market

Honey can be prepared for market in several ways, but there are factors which must be taken into consideration no matter which way it is prepared. The incorporation of small air particles into honey must be avoided at all times. It is extremely difficult to remove these small bubbles and they can prove very detrimental when packing liquid honey in glass. These small air particles become incorporated in the honey when it is thrown from the comb to the walls of the extractor. A honey pump which is sucking air or which is forcing honey through pipes that are too small may be responsible for bubbles in honey. The same trouble may arise if honey is permitted to fall when it is straining. The larger air bubbles tend to rise to the surface; smaller ones remain incorporated in the honey thus reducing its clarity and sometimes rise later to cause a foam on the surface. All honey should be strained as soon as possible after extracting, preferably while it is still warm.

Honey can be extracted and strained much more readily if the combs are placed in a warm room and brought to a temperature of about 90° F. before extracting. A baffle tank should always be used before the strainer in order to remove coarse material so it will not be cut by the honey pump and incorporated in the honey. Where possible, this baffle tank should be double-jacketed and heated in order to keep the honey temperature around 90° to 95° F. to facilitate straining.

Various types of strainers are available. Essentially the straining procedure consists of passing honey through one or more fine mesh cloths or screens. The final strainer should have at least 80 mesh to the inch. A strainer should be constructed in such a manner that the honey will flow rather than drip through it. The O.A.C. strainer takes care of this problem. When using a cloth have it large enough to extend to the bottom of the tank. In order to help prevent incorporation of air when filling the strainer, place an inclined board or funnel on the inside of the tank to direct the flow of honey to within an inch or two of the bottom of the strainer. Honey may also be clarified by passing it through a series of baffled settling tanks in a heated room. Let the honey stand for 24 to 48 hours in these tanks.

Liquid honey when stored for any length of time tends to crystallize or granulate. If this is permitted to occur naturally the crystals formed are often quite coarse and result in an undesirable product. A fairly simple process, however, has been developed whereby the average beekeeper may convert his liquid honey into a finely granulated or processed honey. First it is necessary to obtain some honey which is already finely granulated. This may be procured from a commercial packer or obtained in 30-pound pails from the Apiculture Department, Ontario Agricultural College. This honey, which is referred to as seed or starter, should be permitted to soften in a warm room at a temperature of 80° to 90° F. for 2 to 3 days before it is used. Add to the liquid honey which should be at a temperature of 70° to 75° F., about 10 to 15 per cent of seed honey. Thoroughly mix it into the liquid honey with a small paddle, clean rake or with a motor-driven agitator. Care should be taken not to incorporate air bubbles. When it is thoroughly mixed, run the seeded honey into final containers and store it at a temperature as close to 57° F. as possible. Cellar storage is satisfactory provided the container lids fit tightly to prevent moisture from being absorbed by the honey. At this temperature granulation will proceed rapidly and will result in a finely crystallized honey with a firm smooth texture.

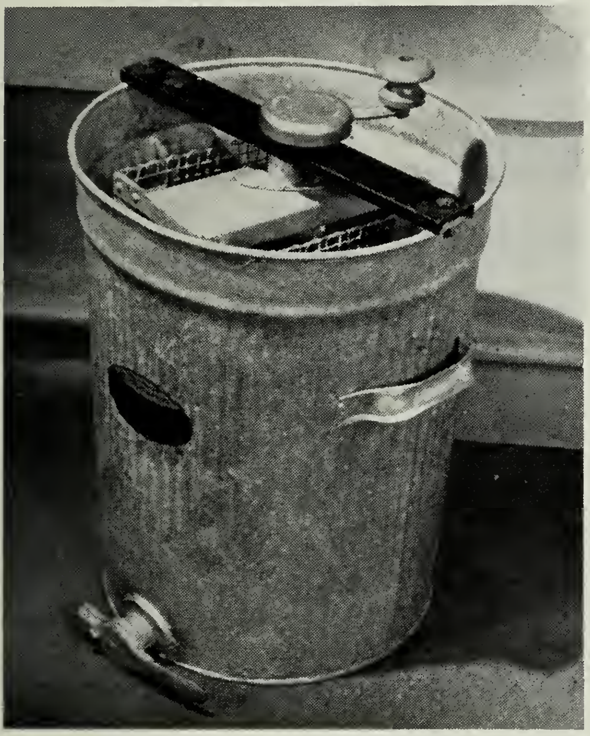


Fig. 45. A two-frame honey extractor.

Properly processed honey will maintain its firm consistency at normal room temperatures, but will break down if subjected to high temperatures or high humidity. If processed honey is too firm for table use, it should be placed at a temperature of from 80° to 90° F. until sufficiently soft. Once it is soft it will not reharden.

Fermentation is the greatest single factor affecting the storage of honey. Yeasts are present in most honeys, but unless the moisture content of the honey rises above 17.2 per cent they remain relatively inactive and cause no damage. It is thus to the advantage of the beekeeper to make every effort to produce a low-moisture honey. As much as 1 to 2 per cent moisture may be removed from combs of capped honey by holding them overnight in a hot room and passing a large volume of warm dry air through the supers. This also warms the honey and facilitates extracting.

Since honey may absorb moisture in storage the only sure way to prevent fermentation is to destroy any yeasts present by pasteurization. This process involves heating the honey to a temperature of 160° F. instantaneously, or to 145° F. for one-half hour. To prevent damaging the honey, it should be cooled as rapidly as possible after this treatment.

Honey should always be stored in a cool dry place.

BEESWAX

Beeswax is an important by-product of the beekeeping industry. If care is taken to collect it all and to handle it properly, it can materially reduce the operating expenses of the beeyard. The main sources of beeswax are cappings, pieces of comb, frame and hive scrapings, and old combs no longer usable. It is estimated that cappings yield from 10 to 18 pounds of beeswax per thousand pounds of honey extracted, depending upon the depth to which the combs are cut when uncapped. Pieces of burr comb and other odd scrapings from colonies should be carefully saved, as during a year's operation they may amount to approximately ½ pound per colony. Old standard Langstroth combs will contain about 2½ to 3½ pounds of wax per super of 10 frames.

Since it is much more difficult to remove the wax from old combs than from cappings or new combs, it is advisable to render these separately. Several

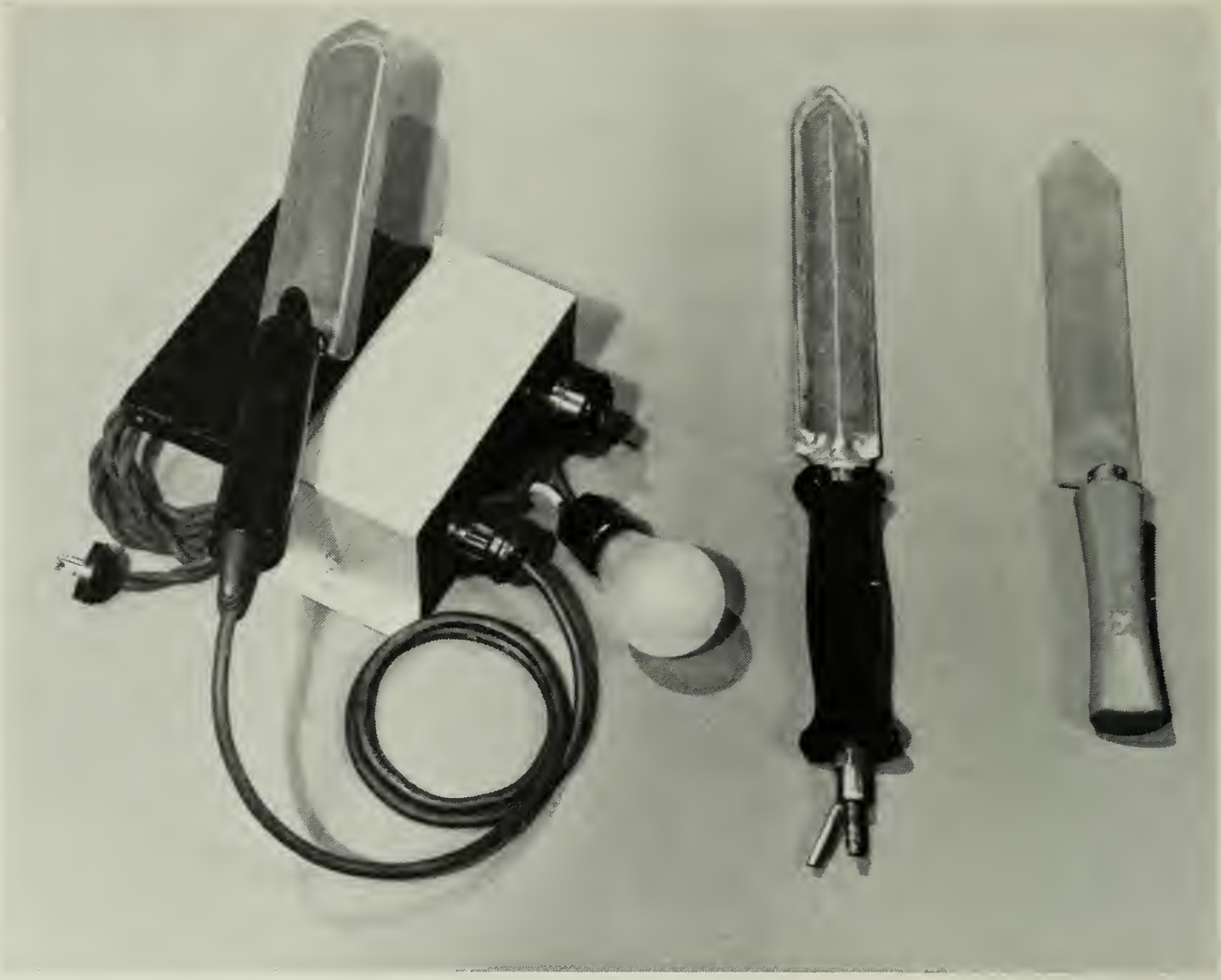


Fig. 46. Uncapping Knives.
Left **— Electric.** ***Centre*** **— Steam.** ***Right*** **— Hot Water.**

methods for rendering wax may be followed; essentially the process consists of heating the combs or cappings to a temperature above 145° F., the melting point of beeswax, and separating the melted wax from other materials present. One of the simplest methods is the solar wax extractor. The cappings or combs are simply placed under a glass frame which is set outside. During the warm summer months sufficient heat will be received from the sun to melt the wax. If using an artificial source of dry heat, care should be taken to avoid overheating as the wax may be damaged or may even catch fire. Whenever wax is heated over an open flame this should be carried on outdoors because of the risk of fire.

Another common method of rendering wax is to place the combs or cappings into a large quantity of water in a tub or tank, and heat this sufficiently to bring the wax to a liquid form. The beeswax will float to the surface, while the honey and most other foreign materials will remain in the water below. The bulk of the wax can be dipped from the surface of the tank and poured into molds. When the tank has cooled any wax remaining on the surface will harden to form a cake which can be removed. Particles of foreign matter adhering to the lower surface of the cake should be scraped off. Further refining can be carried out by re-melting the wax and repeating the same process.

Some of the wax from old combs can be removed by placing them in sacks, submerging these in boiling water and pressing them occasionally. This method is, however, very wasteful. The most efficient means of recovering wax from old combs is to use a steam chest followed by a hot water press. Since many beekeepers are not equipped to carry out this process, old comb is often sent to a rendering plant.

Liquid beeswax should be permitted to cool until the surface reaches the point of hardening before it is poured into molds. A mold slightly wider at the top than at the bottom will allow the solid cakes to be removed very readily. Straight sided containers without inside projections are nevertheless suitable for molding wax.

Beeswax is in considerable demand and is used in many commercial products, the foremost of which are cosmetics, church candles and honeycomb foundation.

BEEKEEPING IN NORTHERN ONTARIO

Northern Ontario as referred to in this chapter is considered as that area north and west of North Bay.

Beekeeping is much different in this section of Ontario than in any other. Large crops of a very fine quality white honey can be produced in many years. Weather is the greatest factor influencing production and wintering in Northern Ontario. A sudden change to a prolonged spell of cool wet weather can take place at almost any time. It appears that if the month of May and the early part of June have plenty of moisture the chances of a good crop in the North are much better than if this period is dry. The springs do not open up until some time in May, and occasionally it is June before good weather is experienced and much brood rearing takes place. Once the weather is favourable the colony builds up very rapidly. This very fast build-up, accompanied by the long days, will cause a very serious swarming problem unless precautions are taken to check it. The nights from mid-August on are very cool, and sometimes brood rearing will cease at this time. Since weather conditions for both spring and fall are not favourable for brood rearing, package bees and over-wintered colonies are sometimes a complete failure. Colonies of bees imported from Southern Ontario during May have proven quite successful when the weather was satisfactory for honey production during June and July.

The main honey plants with their average dates of blooming for two of the Northern areas are as follows:

	Dandelion	*Alsike*	*Fireweed*
New Liskeard area	May 20th	June 25th	July 15th
Englehart and farther North	May 30th	July 2nd	July 15th

In some years, except for fireweed, the honey flow is completely finished by August 15th. Fireweed ceases blooming about September 7th unless frost interferes earlier. Fireweed is an erratic plant with respect to nectar secretion. When the conditions are proper it yields nectar freely, but it cannot be depended upon. This weed, as the name implies, is frequently found after a forest fire. It seems to develop best in areas where fires have passed over fertile well drained soil. Fireweed stands yield only for the first 5 years after being burnt over. Dandelions are very plentiful in most areas, and alsike seems to grow everywhere that land is cleared.

Package bees in Northern Ontario will in some seasons prove quite practical if they have a long build-up period, with good weather for the collecting of dandelion nectar and pollen. In many seasons, however, they will do no more than maintain themselves, especially if July or August should turn cool and wet.

A few colonies of bees are being over-wintered, but in most cases the over-wintering of colonies is not proving successful and very heavy losses are sustained. For those wishing to winter colonies, it is suggested that they use Caucasian bees. The colonies should be wintered outside with an asphalt paper pack and 2 or 3 inches of insulation. A top and bottom entrance should be provided, similar to that described under the section on wintering. It is suggested that the colonies be packed in August and stimulated with a thin sugar syrup. This should bring about a moderate brood rearing in the fall, providing the colony with young bees for winter. In September the feeding may be increased and a thick sugar syrup used in order to prepare the colony for winter.

Those wishing to move bees back and forth from Southern Ontario should try one of the following procedures:

(a) Move bees North about the close of the dandelion flow in Southern Ontario. If the colonies are strong and occupy 2 brood chambers, split them on arrival and introduce a queen to the queenless half. Both sections should have an opportunity to build up on the dandelion flow into good colonies for the main honey flow. This procedure should eliminate most of the swarming problems, although the colonies still need to be watched closely for signs of swarming.

Unless the colonies are in a fireweed area, they may be moved South again during the last two weeks of August. This rule does not always conform with the weather conditions at the time.

(b) Remove a nucleus from each colony before the colony is taken North. Under normal circumstances, the nucleus left behind will build up into a suitable colony for winter. The colony moved North will in this manner have its swarming tendency partially checked yet it will be strong enough to take advantage of the honey flow. In the fall the bees may either be gassed or taken back South as conditions warrant.

If practical, it is recommended that colonies taken North be operated without queen-excluders. Special attention should also be paid to ventilation during the heat of the summer.

Wax moths cannot stand the winters in Northern Ontario, so that very few precautions for wax moth control are necessary.

If the bee yard is placed any distance from a dwelling or near a bush or swamp, precautions must be taken to prevent damage by bears. The best means to protect a bee yard is through the use of an electric fence. This may be constructed according to the Instructions in the Bulletin "Bee Diseases and Pests of the Apiary," 5(a). Once a bear has had a taste of honey it is impossible to keep it away from the bee yard even with an electric fence. Therefore it is essential that the fence be erected before or at the same time the colonies are set out.

HONEYBEES FOR POLLINATION

The modern trend of mechanization in agriculture has resulted in a large-scale destruction of fence-rows and woodlots. This has removed the nesting sites of many of our wild bees, with the result that their numbers have gradually decreased in recent years. The farmer has been forced to rely more and more upon the honeybee for the pollination of many of his crops. The honeybee is exceptionally well suited for pollination work. It is the only pollinating insect directly under the control of man, and may be moved readily from one area to another. Its social organization is such that a large number of insects, often 75,000 or more, are maintained in a single colony during the summer months.

Orchard Pollination

A recent survey of pollinating insects in the Niagara Peninsula showed that 60 per cent of the insects observed on fruit bloom were honeybees. Since the wild insects were not nearly as efficient pollinators as honeybees it is certain that the honeybee is responsible for a major part of the cross-pollination of fruit trees. Many orchard growers now make it a regular practice to rent colonies of bees for the pollination of their orchards. Thousands of colonies are moved into the Niagara Peninsula each spring for this purpose.

One strong healthy colony should be sufficient to pollinate each acre of fruit bloom. Colonies should be placed in small groups (of up to ten) in sunny locations protected from cold winds, either in or beside the orchard. For best results colonies should be moved into the orchard just as the blossoms are beginning to open. Always remove colonies as soon as the petals begin to drop and before spray applications begin.

On some fruits the bees will be of little value unless pollinator varieties in the form of trees or bouquets are nearby.

Legume Pollination

The pollination of legume flowers is as essential to the production of a good seed crop as land preparation, cultivation and weather conditions. Planned pollination means arranging to have enough insects in the field to get a maximum set of seed. It pays! Seed yields have been increased two, three, or even five times! The use of bees for pollination, however, is no guarantee that a seed crop will be produced as quite often some other factor such as weather, harmful insects or improper harvesting, may interfere.

Recommendations for the pollination of various legume crops differ in some respects and are as follows:

Alfalfa — In Ontario the honeybee works alfalfa only for nectar and is not as efficient as certain wild bees in the pollination of this crop. Recent investigations at Guelph show that only 76 out of every 10,000 blossoms visited by honeybees are tripped. However, since honeybees were found to be virtually the only pollinators present on alfalfa, they do contribute to the seed set.

Red Clover — Honeybees work red clover for pollen and nectar. They are efficient pollinators, and frequently comprise 90 per cent of the population of pollinating insects on this crop in Southern Ontario. For best results colonies should be placed right in the field. Three colonies per acre should provide a satisfactory pollinating force if they are distributed throughout the field in groups every 200 to 300 yards each direction. If this is impossible, place the greatest concentration on the east side of the field as bees tend to work into the prevailing winds.

Alsike — This is a favourite source of both pollen and nectar for honeybees. They are efficient pollinators of this clover and average 83 per cent of the total pollinator population on alsike in Southern Ontario. Bees should be used at the rate of 2 to 3 colonies per acre for best results.

Other Clovers — The sweet clovers, white Dutch and Ladino are also very attractive to honeybees and are pollinated to a large degree by these insects. For Ladino clover, 1 colony per acre should provide adequate pollination, while for sweet and white Dutch clovers, colony concentrations should be maintained the same as for alsike.

For alfalfa and red clover honeybee colonies should be placed right in the field, while for the other clovers this is not so essential, as long as the colonies are reasonably close to the field.

Should it be necessary to apply insecticides while colonies are in the field, care should be taken to carry out applications only in the early morning or evening when honeybees are not active. D.D.T. and Toxaphene are the only safe insecticides to use on legume crops which are in bloom.

Greenhouse Pollination

Honeybees are used for the pollination of certain greenhouse crops — particularly cucumbers. In greenhouse pollination best results are obtained by using a colony that is not too strong, as too great a concentration of bees may prove annoying and many bees will fly against the glass. A 3 or 4-frame nucleus is quite suitable. The colony should be placed right in the greenhouse, with no outside entrance. Honeybees in greenhouses, of course, obtain no honey and a satisfactory rental must be paid to the beekeeper for their use, as considerable attention and some feeding are necessary.

General Recommendations

Use only strong disease-free colonies for pollination purposes.

For legume crops place the colonies so the bees will tend to work into the prevailing winds.

Do not place bees out for pollination before the crop they are to pollinate is in bloom. Best results will be obtained if bees are moved into orchards just as the blossoms are beginning to open or at about 20 to 30 per cent bloom for clovers.

If honeybees do not appear to be working the crop for which they were intended, replace them with colonies from another location.

Alfalfa and red clover frequently have a first cutting of hay removed after which the second crop is left for seed. To enable these plants to send up a vigorous second growth and produce abundant bloom, the first cutting should be taken off not later than mid-June. By staggering the first cuttings on alfalfa or red clover fields the blooming period can be prolonged and the available pollinators used to better advantage.

Payment for Pollination Services

There is a general belief that in carrying out its vital service of cross-pollination the honeybee gathers sufficient honey to repay the beekeeper for his trouble in providing colonies for this purpose. In the majority of cases this is far from the truth. To make honeybee colonies available for pollination requires considerable extra time and labour on the part of the beekeeper. Colonies must be examined, prepared for moving, loaded, transported often for many miles, unloaded and sometimes visited and given special attention in the temporary location.

Colonies used in greenhouse pollination do not gather honey and will require additional feeding. In orchards honeybees seldom gather more than enough honey to meet their own daily requirements. And in legume fields, if honeybees are maintained at a concentration of 3 or more colonies per acre they will seldom be able to gather a satisfactory commercial crop of honey. Unless the beekeeper receives a satisfactory rental fee for the use of his colonies, he will not find it attractive to supply honeybees for pollination.

Several methods of payment for pollination services have been worked out between beekeepers and growers. Perhaps the simplest is the flat rate fee of so much per colony used in greenhouse and orchard pollination, and in many instances in legume pollination as well. A share-the-crop system is often used in connection with legume pollination. The beekeeper is guaranteed a certain minimum fee to cover the cost of moving his colonies, plus a certain percentage of the seed harvested. In other cases colonies are weighed into and out of the field and the pollination fee is based upon the difference between the honey actually collected and a figure agreed upon by the beekeeper and grower which would represent an average commercial crop of honey in that area.

Pollination fees will vary somewhat and will be dependent upon a number of factors such as the length of time the colonies are required, the distance the beekeeper has to move them, the attention and feeding required, and so on. A beekeeper who guarantees to supply colonies on a given date and who inspects them and is prepared to exchange them if they are not doing a good job, should naturally receive a higher fee than one who simply unloads his bees in a field and picks them up when they are no longer required. To avoid unforeseen complications beekeepers and growers in many parts of the United States now make it a regular practice to draw up a legal agreement stipulating certain conditions, such as number of colonies, time of placing, use of insecticides, basis of payment, etc. Similar practices might prove useful in Ontario as the demand for pollination increases.

ONTARIO REGULATIONS CONCERNING BEEKEEPING

Ontario laws concerning beekeeping and honey production are found under The Bees Act and The Farm Products Grades and Sales Act and Regulations Respecting Honey.

The Bees Act

The more important matters in The Bees Act concern apiary registration and certificates for the sale or removal of colonies and used beekeeping equipment as part of the disease control programme. Every person keeping bees in Ontario shall register annually with the Provincial Apiarist, Ontario Agricultural College, Guelph. The owner or possessor of an apiary shall not sell, give away or remove any bees or used equipment until he has secured a certificate from the Provincial Apiarist.

It is unlawful to buy, sell or transport beeswax refuse (cappings, slum gum, etc.) or used honeycomb for rendering purposes between April 1st and December 1st except under the written authority of the Provincial Apiarist.

There are numerous sections in The Bees Act dealing with other problems. For example, Section 6 states "No person shall spray or dust fruit trees during the period within which such trees are in bloom with a mixture containing any poisonous substance injurious to bees unless almost all the blossoms have fallen from such trees." Any cases contrary to the above should be brought immediately to the attention of the Provincial Apiarist.

Apiary inspection is operated under the authority of The Bees Act. Colonies infected with American Foulbrood are destroyed. Further details may be found in the Bee Disease bulletin. Any questions concerning regulations or any disease samples should be sent to the Provincial Apiarist, Ontario Agricultural College, Guelph.

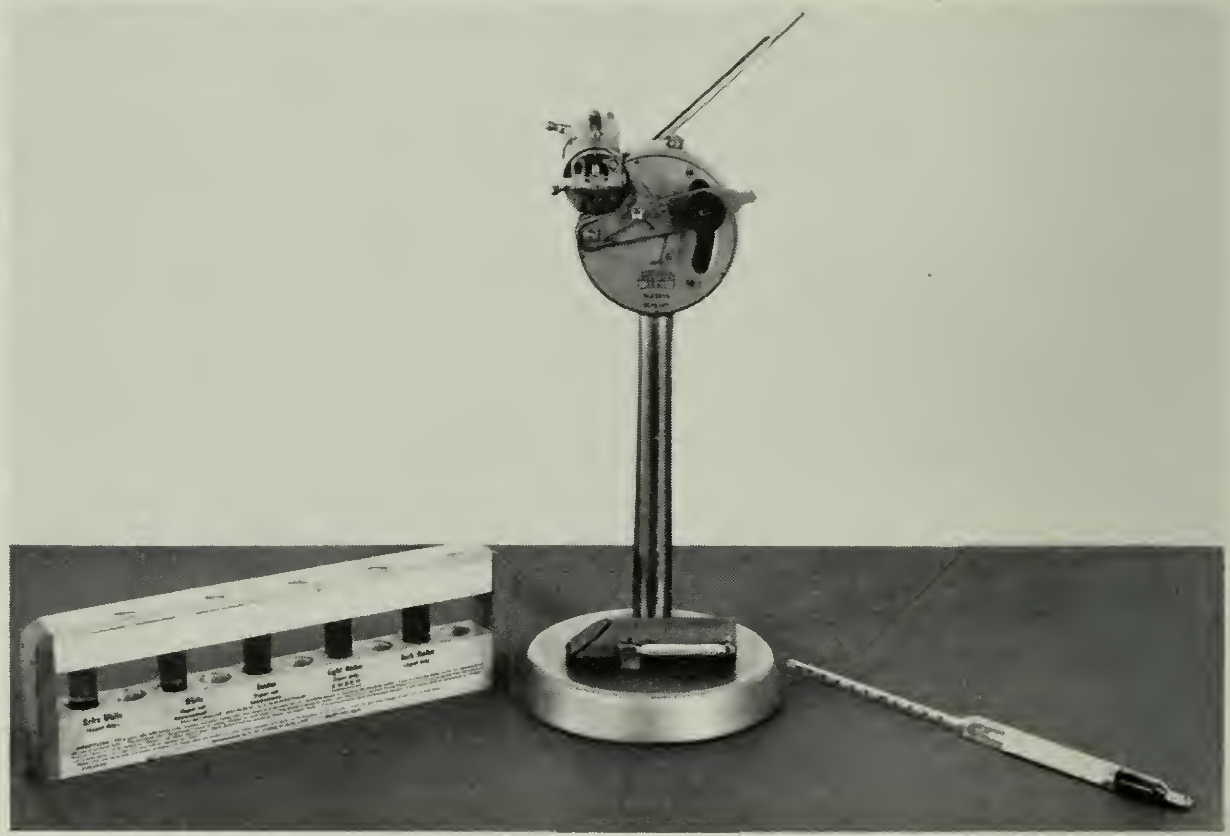


Fig. 47. *Left,* classifier for determining colour. *Centre,* large refractometer with hand model on base. *Right,* honey hydrometer for determining grade.

Honey Grading Regulations

Honey is classified according to colour as designated by the Dominion honey classifier into classes White, Golden, Amber and Dark. The classifier may be obtained from any bee supply dealer.

Honey grades are based on moisture content. The maximum moisture content for each grade is as follows:

Number 1 Grade	17.8 per cent
Number 2 Grade	18.6 per cent
Number 3 Grade	20.0 per cent

Inexpensive hydrometers are available for determining the moisture content of honey. For the honey packer or commercial producer a type of refractometer is more reliable for this work.

The Ontario Grading Regulations do not apply to comb honey or to sales direct from producer to consumer on his own premises. All containers no matter where sold must be marked with the producer's name and address and the word "Honey."

▼

The authors wish to acknowledge the assistance of the Department of Public Relations, Ontario Agricultural College, in providing the pictures reproduced in this bulletin.

REFERENCES

1. *General — Books*
   - (a) *The Hive and the Honeybee — Roy A. Grout
     Dadant & Sons, Inc., Hamilton, Ill., U.S.A. 1949.
   - (b) *A B C and X Y Z of Bee Culture — E. R. Root
     The A. I. Root Company, Medina, Ohio, U.S.A. 1950.

2. *Honey Plants*
   *American Honey Plants — Frank C. Pellett
   Orange Judd Publishing Company, New York. 1947.

3. *Queen Rearing*
   - (a) Queen Rearing — Harry J. Laidlaw and J. E. Eckert
     Dadant & Sons, Inc., Hamilton, Ill., U.S.A. 1950.
   - (b) Practical Queen Rearing — Frank C. Pellett
     Jost & Kiefer Publishing Company, Quincy, Ill., U.S.A. 1945.

4. *Comb Honey Production*
   *Honey in the Comb — Carl E. Killion
   Paris, Ill., U.S.A. 1951.

5. *Bulletins*
   Bee Diseases and Pests of the Apiary — Bulletin 429 (Revised January 1950)
   Ontario Department of Agriculture.

6. *Leaflets* (Available from Ontario Agricultural College, Apiculture Department)
   - (a) Carbolic Acid for Clearing Supers
   - (b) Swarm Control
   - (c) Single Wintering Case
   - (d) Quadruple Wintering Case
   - (e) O. A. C. Honey Strainer
   - (f) Solar Wax Extractor
   - (g) Dyce Method of Processing Honey
   - (h) Average Chemical Composition of Honey
   - (i) Management for Comb Honey Production
   - (j) Melting Honey for Repacking
   - (k) Reducing the Moisture in Honey Before Extracting

7. *Regulations*
   - (a) The Bees Act (Ontario)
   - (b) The Farm Products Grades and Sales Act and Regulations Respecting Honey (Ontario)
   - (c) The Fruit, Vegetables and Honey Act and Regulations (Ottawa)

8. *Journals*
   - (a) Canadian Bee Journal
     W. G. Tolton, Streetsville, Ontario.
   - (b) Western Canada Beekeeper
     308 Affleck Building, Winnipeg, Manitoba.
   - (c) L'Abeille et L'Erable
     57 Ave Begin, Levis, P.Q.
   - (d) American Bee Journal
     Dadant & Sons, Inc., Hamilton, Ill., U.S.A.
   - (e) Gleanings in Bee Culture
     The A. I. Root Company, Medina, Ohio, U.S.A.

9. ***Beekeeping Films*
   - (a) The Realm of the Honeybee
     45 Minutes, 16 m.m., Black and White, Silent. Very good for school use.
   - (b) The Life of the Bee
     20 Minutes, 16 mm., Black and White, Sound. Very good for local meetings.
   - (c) Honeyland
     10 Minutes, 16 m.m., Colour and Sound Cartoon. Very good entertainment.

10. *Bee Supply Houses*
   - (a) A. J. and M. O. Benson
     Billings Bridge (near Ottawa), Ontario.
   - (b) W. A. Chrysler & Son
     Chatham, Ontario.
   - (c) H. M. Clubine
     Brantford, Ontario.
   - (d) Cook's Supplies
     Aurora, Ontario
   - (e) F. W. Jones & Son Limited
     Bedford, P.Q.
   - (f) The Ontario Honey Producers Co-operative Limited
     5 Defries Street, Toronto, Ontario.

11. *Beekeeping Organizations*
   General
   - (a) Canadian Beekeepers' Council
     Secretary, R. M. Pugh, Tisdale, Saskatchewan.
   - (b) Ontario Beekeepers' Association
     Secretary, G. F. Townsend, Ontario Agricultural College, Guelph, Ontario.

   Marketing
   The Ontario Honey Producers Co-operative Limited
   5 Defries Street, Toronto, Ontario.

*Available through most Bee Supply Houses.

**Available for loan through the National Film Board, Ontario Agricultural College, Guelph, Ontario.

BULLETIN 491 MAY, 1952

TOMATOES FOR PROCESSING

HORTICULTURAL EXPERIMENT STATION
VINELAND STATION, ONTARIO

The successful grower produces high yields of high quality tomatoes.

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

THE MEASURE OF SUCCESS

■

Tomatoes for processing are grown as cash crops on general farms where, as for most cash crops, they are usually favored with respect to land, labour and attention. Cash crops are more costly to produce and involve greater risk than do general farm crops, but there is the prospect of greater financial rewards.

Success is dependent upon the production of high acre-yields of high-quality fruit. Successful production is profitable production which, in turn, is measured not by value per ton nor by the size of the grower's cheque at the end of the season, but rather by net returns per acre from land which has been left unimpaired in productive capacity.

Many factors are important in successful production of field tomatoes. These include, choice of land; its preparation and fertilization; the careful setting of well-grown, disease-free plants; cultural practices, such as cultivation; the control of insects and diseases; and last but not least, efficient harvesting of the crop.

CONTENTS

Page
THE MEASURE OF SUCCESS 3
AREAS OF PRODUCTION 6
YIELDS 6
SEED 6
VARIETIES 7
  Recommended Varieties 9
  Varieties Recommended for Trial 10
  Other Varieties 10
  Hybrid Tomatoes 12
WEATHER AS A FACTOR IN CROP PRODUCTION 12
PLANTS AS A FACTOR IN CROP PRODUCTION 14
  Characteristics of Good Plants 14
  Ontario-grown Plants 14
  Imported Plants 14
BASIC SOIL FACTORS IN CROP PRODUCTION 15
  Choice of Location 15
  Selection of Land 16
  Rotation 16
  Soil Testing 16
  Land Preparation 16
FERTILIZER PRACTICES 17
CULTURAL FACTORS IN CROP PRODUCTION 18
  Date for Field Setting 18
  Planting Distance 19
  Care of Plants 19
  Transplanting Solution 21
  Field Setting 22
  Cultivation and Weed Control 23
  Water Requirements 25
  Defoliation 25
INSECTS AFFECTING TOMATOES 26
1952 RECOMMENDATIONS FOR TOMATO INSECT CONTROL 27
DISEASES AFFECTING TOMATOES 29
  Parasitic Diseases 29
  Non-parasitic Diseases 32
SPRAYING FOR THE CONTROL OF TOMATO DISEASES 33
  Spray Recommendations for Control of Tomato Diseases, 1952 35
CONVERSION TABLE 36
HARVESTING TOMATOES 37
  Colour 37
  Care in Handling 37
  Frequency of Picking 38
  Containers 39
  Units of Measurement 39
GRADES FOR TOMATOES FOR CANNING 39
BASIS OF SALE 40
CONCLUSION 41
ACKNOWLEDGMENTS 41

TOMATOES FOR PROCESSING

By A. N. L. Butler *and* E. A. Kerr

The tomato is the most important vegetable crop grown in Ontario for processing being greater, in dollar value, than that of all other processing vegetables combined. Processors paid over $8,750,000 to primary producers for raw tomatoes grown on Ontario farms during 1948, a peak production year. In addition many workers were employed in growing seed, producing plants, processing the raw produce, and in marketing the finished product. Tomatoes in Ontario are manufactured into a wide range of products including canned, juice, puree, soups and condiments.

Wartime and post-war demands enhanced the importance of the tomato and resulted in very substantial increases in acreage. The most significant increases took place in 1946 and 1948. As will be noted in Table 1 the harvested acreage during the peak production year, 1948, was in excess of 47,000 acres as compared to the 5-year (1941-45) average of approximately 28,500.

Table 1. Ontario Acreages and Production of Processing Tomatoes*

Year	Area Harvested	Production
	Acres	Tons
1941	25,860	193,060
1942	27,410	157,930
1943	24,230	141,870
1944	33,440	242,200
1945	31,370	141,330
1946	43,210	277,700
1947	43,150	177,700
1948	47,150	355,700
1949	27,590	161,260
1950	24,380	142,350
5 yr. (1941-45) Average	28,460	175,280
10 yr. (1941-50) Average	32,780	199,110

* From Ontario Vegetable Growers Marketing Board Can Crop Newsletter, June 12, 1951.

Table 2 compares the principal North American tomato-producing areas. Data for the United States are adapted from Table 352, U.S.D.A. Statistics, 1950. Ontario figures are from Can Crop Newsletter, June 12, 1951, the Ontario Vegetable Growers Marketing Board.

Acreages such as those harvested for 1946 to 1948, when Ontario consistently held third place, are not normal for this province. The bountiful harvest of 1948, aggravated by the loss of export markets owing to exchange difficulties, resulted in very substantial stocks of processed tomatoes being carried over. This was reflected in the sharp acreage cut-back in both 1949 and 1950.

Table 2. Harvested Acreage of Processing Tomatoes

Production Area*	10-year Averages 1938-47	1948	1949
	in thousands of acres		
California	103	88	74
Indiana	91	87	73
Maryland	54	27	29
New Jersey	35	25	23
Ontario	33†	47	28
Ohio	27	25	21
Pennsylvania	26	19	20
Virginia	28	17	14
New York	22	24	19
Arkansas	17	8	8
Texas	16	19	17

* Includes all states which had a 10-year average in excess of 15,000 acres.
† 7-year average 1941-47 inclusive.

AREAS OF PRODUCTION

The tomato is a heat-loving crop profitable only in those sections of the province which have a relatively long frost-free period. For this reason production for processing is confined to those areas of southern Ontario bordering on Lake Erie and Lake Ontario south of a line from Wallaceburg to Toronto; to a narrow strip of land adjacent to and north of Lake Ontario extending east from Toronto as far as Napanee; and to a very limited area south of Georgian Bay around Collingwood.

While tomatoes for processing are grown in as many as 21 counties, over 50 per cent of the acreage and over 56 per cent of the tonnage is produced in the counties of Essex and Kent, where soil and climate are particularly favorable for this crop. Prince Edward county is also important with approximately 13 per cent of the total acreage.

YIELDS

Average acre-yields of processing tomatoes in Ontario are too low. While favorable yields have occasionally been harvested, as was the case in 1948, average yields over a period of years have represented little, if anything, over cost of production. Many growers consistently produce crops which yield at least two or three times the provincial ten-year (1941-50) average of 6.0 tons per acre. The fact that the average yield is so low, however, indicates that too many of our processing tomato crops represent unprofitable farm enterprises. This is borne out by cost-of-production studies compiled by the Farm Economics Branch, Ontario Department of Agriculture.

Table 3 compares the average yield of processing tomatoes in Ontario with that of the principal production areas of the United States. The information is from the same sources as for Table 2.

Many factors influence yields, but, apart from seed, two may possibly be singled out as contributing to the low average yield in Ontario. They are the use of inferior plants for field setting; and degraded soils for actual crop production.

TABLE 3. AVERAGE TOMATO YIELDS IN TONS PER ACRE

Principal Production Areas	**10-year Averages 1938-47**	**1948**	**1949**
	tons	**tons**	**tons**
California	7.9	10.9	14.0
New York	6.9	8.1	8.4
Ohio	6.3	10.2	7.7
New Jersey	6.1	6.4	6.9
Michigan	6.0	10.0	6.2
Ontario	**5.8***	**7.5**	**5.8**
Pennsylvania	5.4	8.2	7.4
Indiana	5.0	6.5	4.8
Illinois	4.8	8.6	5.9
Maryland	4.3	4.1	5.7
Delaware	4.3	3.6	5.0
Virginia	3.6	4.3	3.6

* (7-yr. av.) 1941-47 inclusive.

SEED

Normally the processing companies supply plants to the contract growers who, therefore, have no control over seed. Nevertheless, since seed definitely influences production the contract grower should be aware of its importance. The cost of the seed is a minor item in the total cost of production. The grower of processing tomatoes cannot afford to use plants grown from inferior seed or from seed of an inferior variety or strain.

Seed should be obtained from a reputable source. The crop should be grown under isolation to avoid mechanical mixture and the possibility of any cross pollination with other strains or varieties. The seed crop should be so uniform and free from disease that it could pass the inspection given Registered and Certified seeds by the Canada Department of Agriculture. After rogueing, the entire crop should be used for seed. If only the last part of the crop is used there will be a tendency, through the years, for the stock to become later. The seed should be harvested and handled very carefully to eliminate the possibility of mechanical mixture.

Progressive seed firms are now giving tomato seed the hot-water treatment. When properly carried out, this treatment kills any disease organisms which may be seed-borne. Weaker seeds may be killed (to advantage) but the seeds that will produce healthy, vigorous plants are unharmed.

A few processors are still reclaiming seed from canning factory operations. This is a risky procedure. Even if the seed is saved from a load that appears to have particularly high quality, the load might be from a field of an inferior variety or strain grown under exceptionally favorable conditions. Again there might be a mixture of varieties having different adaptations, or seasons of maturity. Under the best of conditions the field or fields from which such seed came would not be rogued for uniformity or purity of type. Canning-factory waste is a poor source of seed.

If a change in seed-source or variety is contemplated the seed should be bought a year ahead of time, and tested. In fact this is good practice even if a change is not contemplated. It gives the processor assurance that he has the strain that has proven satisfactory under his conditions.

VARIETIES

New varieties of tomatoes are constantly being introduced. Only a few of these prove of use to processors in Ontario. Trial grounds conducted by experiment stations, processors, and seed growers are the best means of determining the adaptability and usefulness of these new introductions. Even when preliminary tests are favorable the processor should grow several acres for trial before planting a large proportion of his acreage to a new variety.

A variety should be adapted to the land on which it is to be grown. It is not economical to grow a late variety like Rutgers in an area where the first frost usually comes in September. Susceptible varieties should not be grown on wilt-infested soil. Differing soil or weather conditions may cause certain varieties to be satisfactory in one part of the province but lack in quality or productiveness in another.

The variety to be grown is determined to some extent by the type of product to be manufactured. For the whole-pack, a medium size tomato that will hold up during processing is wanted. For soups and puree a variety with a high sugar/acid ratio is preferred. For tomato juice a slightly acid fruit gives a more sprightly taste. A deep red colour is very important especially if the tomatoes are being made into strained products.

The contract grower wants a variety that yields well, has large fruits, is easy to pick, and can be harvested in a relatively few pickings. The processor

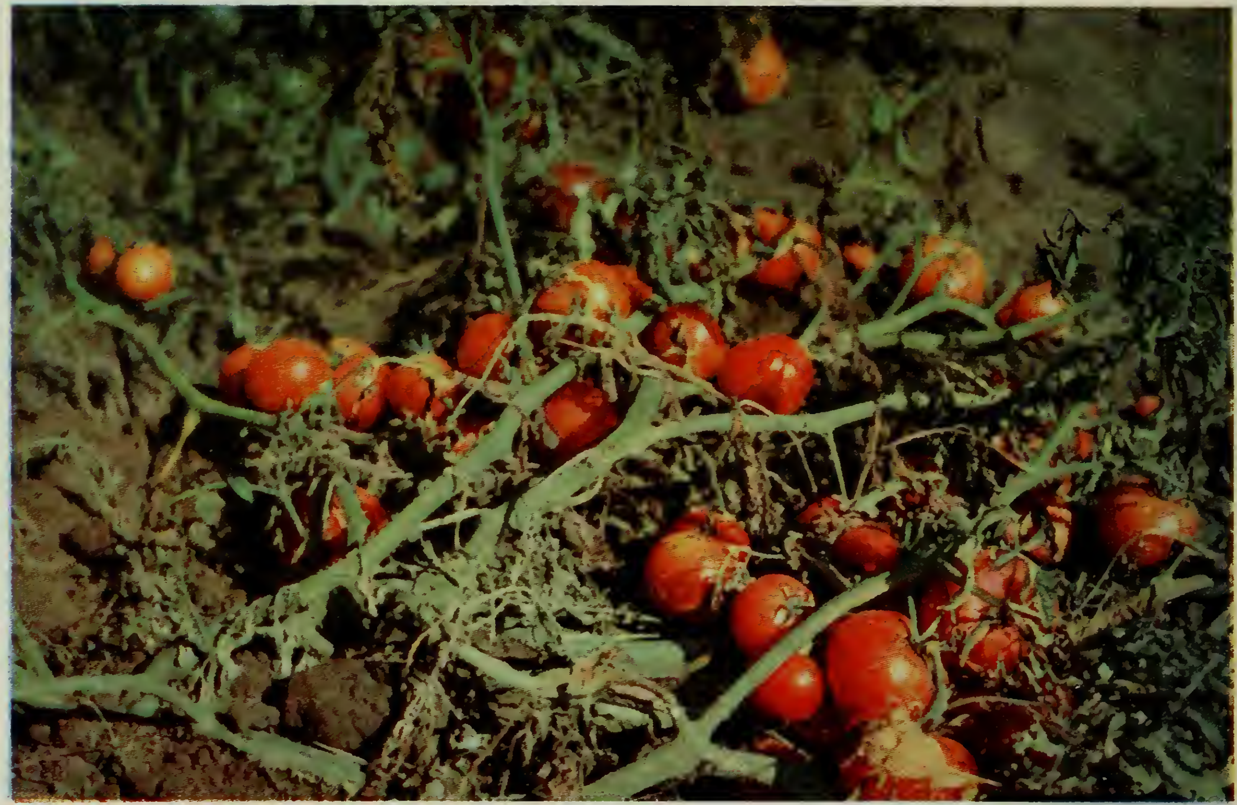


FIG. 1. John Baer, while still a leading variety, is giving way to newer introductions. When grown under ideal conditions this variety performs well. When conditions are less than ideal plants defoliate badly and exposed fruit grades poorly.

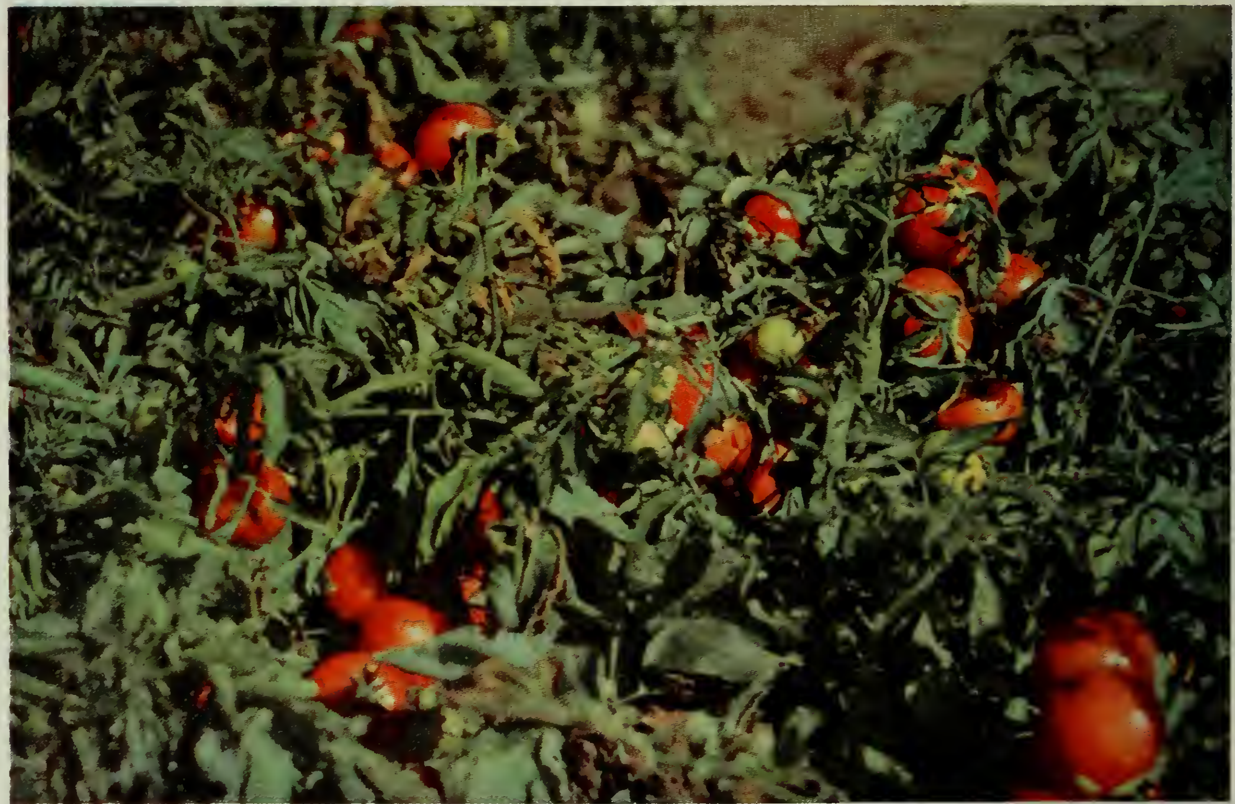


FIG. 2. Red Jacket, showing good foliage cover. This variety has potato-leaf foliage and the uniform-green fruit character. Figs. 1 and 2 were both taken on Sept. 15, 1951 in the test plots at Vineland. Plants had received the complete spray program.

wants tomatoes that have good colour, are uniform, and free from blemishes such as leather top, cracks and disease spots. In addition he wants to operate his factory at capacity for as long a period as possible. To this end, many processors contract for at least two varieties, one of which comes to peak production a week or ten days before the other.

Most of the tomato varieties grown for processing in Ontario are included in the accompanying variety sections. The recommended varieties are ones which have been grown extensively by processors and have proved satisfactory. Those recommended for trial are recent introductions some of which will likely become important varieties in the next few years. The other varieties listed have limited adaptability, are of very recent introduction, or are of special interest.

Season of maturity is rather difficult to assess in terms of days from planting. Condition of the transplants, time of setting, soil conditions and weather as well as the inherent earliness of the variety or strain determine when the first fruits will ripen. In the following sections the varieties are arranged according to their inherent earliness but without any attempt being made to assign a definite number of "days to maturity" to them.

RECOMMENDED VARIETIES

Geneva John Baer. This strain of John Baer has better colour, and is slightly earlier in maturity than most other strains. Furthermore, the fruits have a little better colour, but are smaller in size. The growth habit is somewhat spreading. The plants are quite susceptible to defoliation by Septoria leaf spot and other foliage diseases. This unduly exposes the fruit to the sun. Leather top and sunscald are common defects especially when the crop is grown on the lighter soil types. It is probable that John Baer will be discarded by most canners in the next few years. At present there is no variety to replace it completely.

Red Jacket. This variety is characterized by heavy foliage of the potato-leaf type. The fruit is larger in size and of better colour than that of other varieties of the same season. Immature fruits have the pale green shoulder known as uniform-ripening. Red Jacket seems to be less widely adapted than most varieties but under favorable conditions produces a heavy crop. In some areas the colour has been only fair. Probably because of its heavy foliage this variety has a tendency to be more readily attacked by aphids and foliage diseases than most varieties. This tendency can be overcome by following the spray program. The fruits are slightly flattened and generally smooth but with a tendency toward a large blossom-end scar.

Stokesdale. A day or two later than John Baer, Stokesdale is a heavy producer of medium-size fruits. Internally the fruits have fairly good colour and medium solidity. It has found most favour in the Niagara Peninsula.

Longred. Like Red Jacket, Longred has the uniform-ripening characteristic. The foliage is rather finely divided but gives fairly good cover to the fruit. The plants are quite productive yielding a large number of medium size, deep fruits that are exceptionally smooth. At Vineland, Longred has not usually had the internal quality of Red Jacket, but in some parts of Ontario it is preferred.

Early Baltimore. Grown extensively in Southwestern Ontario for the manufacture of juice. The vines are somewhat spreading, producing a heavy crop of large, flattened and slightly ridged fruits. Internally the fruits are solid and have good colour.

Garden State. A semi-determinate variety. Garden State is too late for most parts of Ontario except Essex and Kent counties. Fruits are of good quality with thick, firm flesh of excellent colour. The acidity of the fruits is lower than in most varieties.

Rutgers. Rutgers is the standard by which other varieties are judged for quality. It is a late-maturing variety, adapted to many soil types, and somewhat resistant to fusarium wilt. Plants are upright in growth habit and provide good cover for the fruit. Fruits are intermediate to deep in shape, medium in size, thick-walled and have a deep red colour. Extensive production of Rutgers is restricted to Southwestern Ontario.

VARIETIES RECOMMENDED FOR TRIAL

Improved Wasatch Beauty. This high-yielding variety comes to peak production early. The vines are determinate in growth habit. The fruits have good size, good thickness of flesh and good red internal colour. It seems to have regional adaptation.

Moscow. Moscow is very similar to Improved Wasatch Beauty but is slightly later and has slightly better quality. These two are promising as varieties to come in early and thus spread the peak of deliveries at the processing plant.

Wisconsin 55. Wisconsin 55 is an early variety coming to peak production between John Baer and Stokesdale. The fruits are large, flattened and somewhat ridged at the stem end. It is claimed to be resistant to cracking. Internally the fruits have good colour and thick walls. The plant is rather sprawling and the fruits are exposed more than is desirable. The variety is somewhat resistant to early blight and fusarium wilt.

Improved Garden State. This variety comes into production slightly before standard Garden State. Plants are semi-determinate in growth habit but provide good foliage cover for the fruit which is medium to large in size and of good colour.

Ontario. A productive, indeterminate variety with a uniform apple-green, immature fruit-colour. The fruits are large, solid, exceptionally deep and possess good colour. It is susceptible to defoliation diseases and must be sprayed regularly.

Camdown. A late-midseason variety of large size, good internal colour, and solid flesh. The plant is rather spreading in growth habit and is somewhat susceptible to defoliation diseases.

OTHER VARIETIES

Bounty. Bounty is widely grown in Ontario as an early market variety. Unfortunately the last of the crop often finds its way to the processor's platform. While the fruits may be acceptable for the whole pack, their poor internal colour makes them definitely undesirable for strained products.

All Purpose. All Purpose is an early, high-quality tomato of determinate growth habit. It is adapted for market or, in districts with a moderately short growing-season, for processing. It may be rather small in size unless grown under very favorable conditions.

Gem. Introduced by the New York Agricultural Experiment Station in 1947, at the same time as Red Jacket and Longred. Gem is an early, determinate variety with the uniform-ripening character. It is a little later in maturity than Bounty but has better colour. In general it has not been as widely accepted in Ontario as Red Jacket or Longred.

Valiant (Stokesdale No. 4). Valiant is primarily an early, market variety. The fruits are exceptionally deep and the quality is good. The plant-type, however, is very sprawly and the foliage sparse. The fruits frequently develop leather top.

Early Jersey. A high-quality Bounty-type tomato. It is a little later in maturity and slightly smaller in size than Bounty. Early Jersey defoliates badly.

Scarlet Dawn. Scarlet Dawn is an early, fairly productive variety with medium vine-growth. The internal colour is good and the flesh solid.

Stokesbaer. A recent introduction that lacks uniformity. It has some promising features and may be of use for processing when the stock has been improved as to uniformity.

John Baer (Bonny Best, Chalk's Early Jewel, Cobourg, Harvest). John Baer has long been the standard early processing tomato. The variety is rapidly losing favour with canners because of its susceptibility to foliage diseases. Defoliation results in poor colour and high incidence of leather top. John Baer is one of the earliest processing tomatoes and, when grown under very favorable conditions, produces a satisfactory crop of good quality fruit.

Queens. A 1950 introduction, Queens was developed from the cross Valiant x Rutgers as an early, market tomato for New Jersey. It matures in Stokesdale season and has fruits which are medium in size and deep globe in shape. The walls are thick and the seed cavities small which may account for the fruits being very firm. The foliage is rather sparse making the fruit susceptible to leather top.

Urbana. Urbana is an early, determinate variety. The fruit has excellent quality but the size is small.

Pritchard. A semi-determinate, early-midseason variety that is very productive. The fruits are smooth, thick-walled, medium in size and mild in flavour. Under some conditions the internal colour is somewhat pale for a processing tomato.

Early Rutgers. A number of entirely different stocks are being sold under this name. They range in season of maturity from John Baer to the standard Rutgers. The quality is just as variable between stocks. Those stocks which are essentially similar to Rutgers except for season, have a definite place as processing tomatoes in Ontario.

Pan America. This variety is practically immune from fusarium wilt and may have a place where this disease is a problem. Fruits are medium in size and fairly deep in shape. The colour is good and the cell walls thick. The seed cavities are slightly larger than is desirable in a processing tomato. It is rather late for most districts.

Keystone 40-46. This is a rather late, semi-determinate variety. It has medium-large fruits with thick walls and excellent colour.

Marglobe. Introduced as a shipping variety resistant to nailhead rust and fusarium wilt, Marglobe is a late, vigorous-growing variety which produces globe-shaped, solid-fleshed fruit. Under some conditions the size may be somewhat small. Some seed companies are offering strains which have been selected for larger size.

Indiana Baltimore. This is an excellent strain of Greater Baltimore. The fruits are large and flattened. The colour is very good and the variety is therefore desirable for the manufacture of strained products. The season of maturity is rather late, however, and the selection known as Early Baltimore is more popular in Ontario.

Southland. A recent introduction, Southland is moderately resistant to early blight and almost completely immune from fusarium wilt. It is relatively resistant to blossom-end rot and collar rot. Southland is productive but late. The fruits have excellent quality but are rather small.

HYBRID TOMATOES

The merits of hybrid corn are well known. First generation (F_1) hybrid tomatoes also have advantages over standard varieties. Chief among these are greater vigour and productivity. Also an F_1 hybrid is usually earlier than the average of its parents.

The chief deterrent to the use of F_1 hybrid seed is cost. At present the hybridization procedure is time-consuming and must be done by skilled technicians. Plant breeders are now at work incorporating into inbred lines, genetic factors which will greatly increase the ease and speed of the hybridization technique. This should effect a substantial decrease in the cost. However, F_1 hybrid seed will always be much more expensive than seed of standard varieties.

Second generation (F_2) hybrid seed possesses many of the advantages of F_1 hybrid seed. F_2 plants give about one-half the *increased* production given by F_1 plants. F_2 seed should cost only a little more than seed of standard varieties. The main disadvantage of F_2 tomatoes is the variability in type of growth, season of maturity, and size, shape and quality of fruit. The variability may be reduced by choosing parents which are reasonably similar. Actually this variability is not a serious disadvantage if the tomatoes are to be used for any strained product such as juice or puree where a blend is produced.

Most of the hybrid tomatoes now available commercially are designed for home garden, early market, or greenhouse. A few F_1 hybrids such as Clinton and Keystate are late-midseason tomatoes with excellent quality for processing. Those growers in Southwestern Ontario who consistently get high yields should give these hybrids a trial. Of all the varieties and hybrids under test at Vineland, Keystate hybrid (Rutgers x Pritchard) has consistently been near the top in total production.

The F_2 hybrid tomatoes that are commercially available have not yet (February 1951) been tested sufficiently to warrant a recommendation. This is partly because the formulation of many of them is being changed from year to year.

WEATHER AS A FACTOR IN CROP PRODUCTION

Many factors contribute to efficient production and these with possibly two exceptions, weather and plants, are usually within the control of contract growers.

Weather can and does have a profound influence upon the growth, development and maturity of the crop during the entire season and upon the ability of growers to perform, at the proper time, many necessary production and harvesting operations. Weather also has a very considerable influence upon the development of certain tomato diseases.

Extremes of temperature during the growing season may be reflected in fruit-shape and in reduced yield. The first fruits are often rough or fasciated owing to the influence of cold weather upon the early bloom. Unusually high temperatures during late July and August may cause many blossoms to fall off with a proportionate yield decrease.

While contract growers do not have any control over the weather they can, by efficient production methods, lessen the effects of adverse weather. For example: heavy rains can ruin the structure of bare soils through physical impact and, depending upon slope, cause damage through sheet or gully erosion. Cover crops sown on fall-plowed land, and in cultivated crops such as corn and tomatoes at the time of the last cultivation, are helpful in reducing erosion on sandy loam and loam soils.

Properly hardened plants are better able to withstand adverse weather. This is often overlooked by growers. Plants lacking sufficient hardening may not be able to withstand the adverse conditions to which newly set plants are often exposed. The following excerpt from Ontario Bulletin 464[*] may be of interest in this connection.

"*Hardening* – The toughening of tomato plants prior to field setting is referred to as hardening. During the hardening process tomato plants undergo certain changes, some of which are readily apparent. Growth processes are slowed up, plant tissues become firm or hard, and purple pigments develop, first on the stems and later on the leaves. The degree to which these characteristics develop will depend upon the severity of the hardening process. Hardening may be induced by exposure to sub-optimum temperature and by withholding moisture. Carbohydrates, which would normally have been utilized in the formation of new tissue, are stored within the plant. This reserve is drawn upon by the plant for the development of a new root system.

"Tomato plants are frequently subjected to low temperatures after field setting. It is usually considered that the purpose of hardening is to enable plants to survive these low temperatures. Actually the lowered moisture content assists plant tissue to withstand any adversity including low temperatures, high temperatures, cold chilling winds, hot dessicating winds, drought, and bright sunshine.

"Excessive hardening, which is recognized by a distinct stunting of the plant coupled with an excessive development of blue pigment in the foliage, is not desirable. Plants so treated are slow to recover when set in the field. The more severe the hardening the slower is the recovery and the smaller will be the crop prospect. Plants which are not sufficiently toughened are equally objectionable. They are usually soft, spindly, and more likely to suffer loss especially when transplanted under adverse conditions. Good plants are grown slowly but continuously."

There is evidence that in Southwestern Ontario average yields are higher during hot, dry seasons than during cool, wet seasons. In Eastern Ontario, where much of the acreage is produced on light or shallow soils, seasons with normal or above normal precipitation have produced the highest average yields. In this latter area during dry seasons, plant development is usually limited, and some of the crop which develops is affected with blossom-end rot.

Where a complete spray program is not followed weather can have a profound influence upon the development of, and losses attributable to, fungous diseases. For instance, contract growers in many parts of Ontario have experienced severe losses from late blight during seasons characterized by cool, moist, humid weather. Losses from Septoria leaf spot and early blight, which are more severe during moist seasons, have also been greater than was realized.

---

[*] Tomato Plants for the Processing Industry.

PLANTS AS A FACTOR IN CROP PRODUCTION

CHARACTERISTICS OF GOOD PLANTS

The potential crop is in the plant. Its excellence, other things being equal, determines eventual yields and profit. The characteristics of good plants are,—

1. The variety should be acceptable to the processor and adapted to the area where the crop is to be grown.
2. Plants should be true to a productive strain of the selected variety.
3. Plants should be stocky and from 6 to 10 inches in height when they leave the nursery.
4. Plants should have stems which are at least one-quarter inch in diameter about two inches above ground level.
5. All plants within a given lot should be reasonably uniform as to size.
6. Plants should have reasonably straight stems which are firm but not hard.
7. Plant stems should show some purpling up to the second or third node.
8. Plant foliage should be a good normal green in colour.
9. Roots should be vigorous and well developed.
10. Plants should be free from disease. This applies to both tops and roots.
11. Plants should be ready for field setting when danger from frost is past.
12. Bundles of plants for shipment by transport should be wrapped in a manner and shipped under conditions which will discourage heating and the development of foliage diseases. (From Bulletin 464.)

ONTARIO-GROWN PLANTS

Most of the tomato plants used to establish contract acreage in Ontario are domestically grown. While a few tomato growers produce their own, most contract growers are dependent upon processors for their plants. In Eastern Ontario the bulk of the plants are grown by processors. In Central and Western Ontario, and to a lesser extent east of Toronto, independent plant growers produce plants for processors and contract growers.

Disease-free transplants are essential for effective control of tomato diseases in the field. Toward this end, plant growers should exercise those preventive and control measures which are necessary for the production of healthy plants. These measures include the elimination of unsanitary conditions in and around plant-growing establishments, the spraying of seedlings before they are transplanted into flats or beds, and the spraying of transplants at weekly or 10-day intervals thereafter. The time interval will depend upon the weather and upon plant growth. The final spray in the nursery should be applied about 4 or 5 days before plants are transplanted to the field.

IMPORTED PLANTS

Tomato plants imported from the United States amount to somewhat over twelve per cent of our total requirements. While success and enthusiasm have not always been associated with their acceptance and use, imported plants are presently being used in increasing numbers by contract growers in Southwestern Ontario. Success with imported plants is dependent upon thorough planning and upon an efficient organization at both source and destination, so that only well-graded, disease-free plants of acceptable size are shipped, that no delays are occasioned in transit, and that plants are field-set the day of their arrival or very soon thereafter. Where such organization has been lacking a loss of plants has invariably been experienced.

Imported plants are field-grown. They are, therefore, well hardened and better able to withstand adverse conditions when transplanted into production fields. Imported plants are often available several days in advance of most domestically grown plants. This fact has contributed toward early planting and early growth. A criticism of Georgia-grown plants has been that they are often too large and the best fields have been pulled before contract growers in Ontario are ready for plants. There is, however, a choice of growing areas since imported plants are available from Georgia, Virginia, West Virginia, Delaware and Maryland.

BASIC SOIL FACTORS IN CROP PRODUCTION

Since the tomato is a soil-exhausting crop, the land devoted to its production needs careful handling if its productive capacity is to be maintained unimpaired.

The low average-yield of processing tomatoes in Ontario has been attributed in large measure to the use of unimproved and degraded soils. Yield could be substantially increased if more attention were given to basic soil factors when selecting acreage. This is essential not only to reduce the number of unprofitable enterprises but also to avoid further soil degradation. On the basis of average acreage and yield records for the ten-year period 1941-50 an increased yield of only one ton, or 33 bushels, per acre would have permitted almost 5,500 acres to be retired from tomato production. This acreage could have been devoted to some other crop, preferably a soil-improving crop to the advantage of both grower and processor. If the average yield had been raised to 8 tons or 266 bushels per acre, some 11,000 acres, or almost one-third of our total acreage, would not have been necessary.

CHOICE OF LOCATION

Tomatoes are sensitive to excess water. It is well, therefore, to avoid land which is subject to flooding. As a precaution against development of disease avoid, if possible, locating tomatoes in proximity to shelter belts and wind-breaks. These, especially on the windward side, serve to slow up or to stop breezes which dissipate fogs in the early morning, and dry tomato foliage following a heavy dew or a rain. Odd-shaped fields and odd corners which are difficult to spray should not be used as they may serve as starting points from which disease may spread to the entire acreage.

Tomatoes should not be planted in proximity to a black walnut tree or to the place from which this species of tree has been removed. A substance called juglone, contained in the roots and nuts of black walnut, is highly toxic and causes tomatoes to wilt and die.

Trees draw heavily on soil nutrients and moisture. Tomatoes planted along fence lines in which trees are growing are therefore not very productive. Much of the fruit which develops on plants situated within feeding range of tree roots is usually affected with blossom-end rot. If generous headlands are left along tree-lines valuable plants will be saved, conditions will be less favorable for disease, and the average yield for the planted area will be increased. Headlands should be sown to some other crop preferably a soil-improving crop.

SELECTION OF LAND

While tomatoes may be grown on a wide range of soil types, well-drained clay-loam soils are preferred. Good underdrainage is essential, however, since early land preparation, early field setting and subsequent early growth and maturity, are dependent upon good drainage. This is especially true in years of excessive moisture. Land with too much slope should be avoided owing to the danger of soil erosion. If land with a slope must be used it is well to set plants in rows across, rather than up and down the slope.

The tomato crop has a definite place in the rotation program of many contract growers. When such is not the case it is well to decide, at least a year in advance, where tomatoes will be grown so that land can be properly managed and soil samples taken for analysis.

ROTATION

The soil should be well supplied with organic matter. Growth and yield will, therefore, be improved if the tomatoes are grown in a rotation which includes hay and pasture crops and green-manure crops, or manure supplemented with commercial fertilizer. While tomatoes generally follow a sod crop in the rotation, on the heavier soil types it may be desirable to plant tomatoes the second year after sod to avoid excessive late growth.

The influence of previous crops upon the development of disease must not be disregarded, since certain tomato diseases are carried over in the soil on plant refuse and in potato tubers. Therefore, tomatoes should not be grown on land which has produced tomatoes or related crops such as potatoes or peppers, during the previous five years.

SOIL TESTING

The production of good crops of tomatoes requires a certain minimum level of soil fertility. Soil analyses, carefully made from representative soil samples and properly interpreted, can serve as useful guides in providing the required level of plant nutrients.

Soil-sampling instructions and question blanks may be obtained from your Agricultural Representative, or from any of the following: Department of Soils, Ontario Agricultural College, Guelph; the Western Ontario Experimental Farm, Ridgetown; or the Kempville Agricultural School, Kempville.

Tomato growers who fail to take advantage of the soil-testing service offered by the above laboratories or by reputable commercial enterprises are overlooking an important factor in the production of profitable crops.

LAND PREPARATION

Sod land for tomatoes should always be plowed in the late summer or early fall so that the fibrous material will have an opportunity to decompose. If the sod crop is not a legume, 100 to 150 pounds ammonium nitrate or its equivalent should be broadcast just before plowing. Manure, for best results, should also be

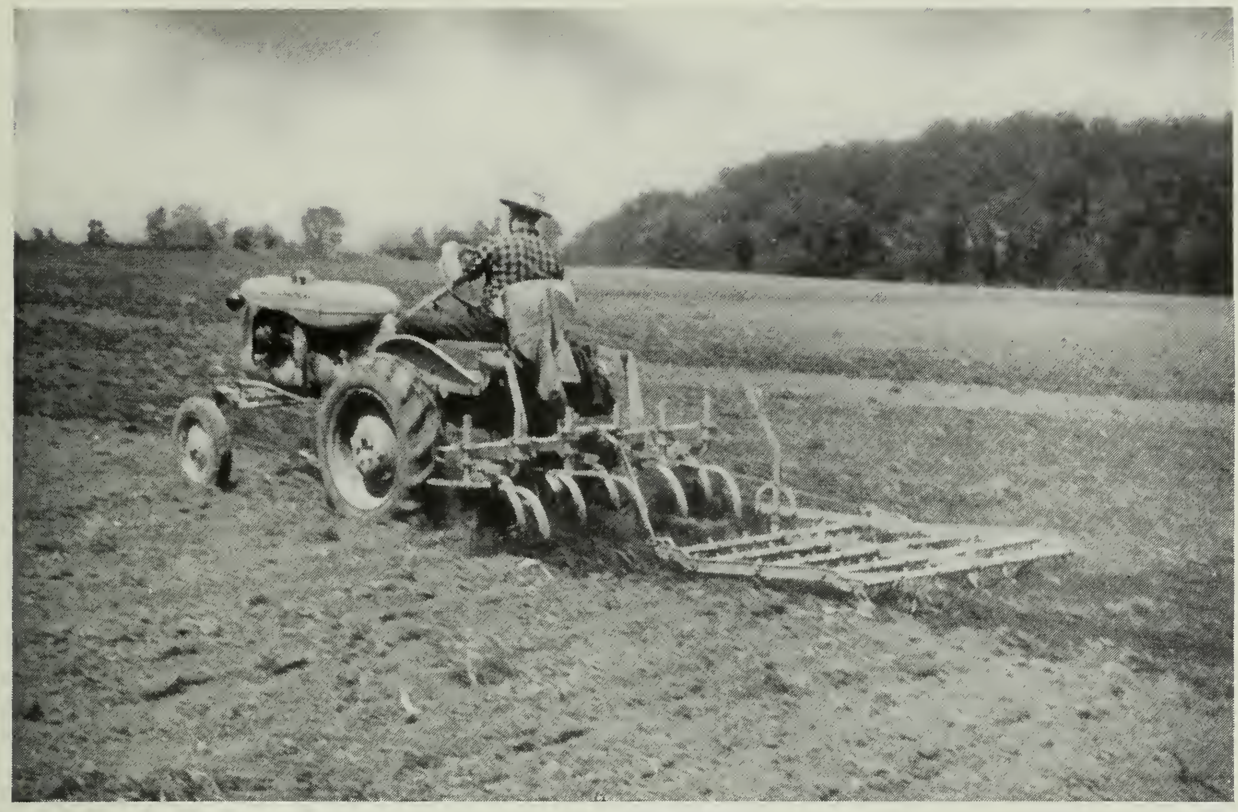


FIG. 3. A well-prepared soil facilitates transplanting, encourages plants to become established more quickly, and, in general, creates conditions more favorable for crop development.

applied just before plowing. Sandy-loam and loam soils plowed in late summer or early autumn, should not be left bare over winter. A fertilized cover-crop sown at this time will utilize and hold soil nutrients, reduce soil erosion and contribute organic matter.

Heavy, spring applications of manure should be avoided. Micro-organisms feed upon nitrogen while breaking down fibrous material. Micro-organisms would, therefore, compete with tomatoes for available nitrogen early in the season. Also, excessive quantities of undecomposed straw-manure may serve to accentuate a drought by drying out the soil and interfering with the upward movement of soil moisture. During seasons of ample rainfall the decomposing manure may, by the release of nitrates, contribute to late growth and late maturity.

Thorough land preparation prior to setting the plants in the field is very important. No amount of cultivation after the plants have been set will take the place of adequate and thorough preparation before planting. Frequent working of the soil prior to field setting stimulates the germination of weed seeds and thereby reduces the problem of weed control later in the season. Also, well prepared soil enables a better job of transplanting to be done, encourages plants to become established more quickly, and in general creates conditions more favorable for crop development.

FERTILIZER PRACTICES

Familiarity with the fundamentals of soil management is basic to the intelligent choice and application of commercial fertilizer for field tomatoes. For a discussion on this subject readers are referred to Ontario Bulletin 463, Soil Management and Fertilizer Use, available from the Statistics and Publications Branch, Ontario Department of Agriculture, Toronto, or any Agricultural Representative.

The use of a transplanting solution is an important part of the fertilizer program for field tomatoes. For a discussion on this subject see page 21.

The quantity and the analysis of commercial fertilizer which should be applied will vary depending upon the soil type, the soil analysis, crop rotation, previous cropping practice, soil organic-matter content, and the availability of nutrients in the fertilizer. Information relative to previous land treatment and cropping practice is, therefore, essential so that consideration may be given to nutrients contributed from sources such as manure, cover crops and crop residues. The following statement from Ontario Bulletin 463 is of interest in this connection. " . . . valuable and even essential as fertilizers have proven themselves to be, they can only *supplement* and never *replace* good farm practices, as they are reflected in organic content of the soil, good tilth and proper aeration."

Tomatoes are heavy feeders. A ten-ton crop removes from the soil approximately 100 pounds of nitrogen, 35 pounds of phosphoric acid and 175 pounds of potash or the equivalent of these nutrients supplied by 300 pounds of ammonium nitrate, 175 pounds of 20 per cent superphosphate and 290 pounds of 60 per cent muriate of potash. Crops heavier than 10 tons per acre would remove correspondingly greater quantities of these essential nutrients. Since nutrients, especially phosphorus, do not all become available during the year of application a quantity even greater than is required for the tomato crop must be applied.

For the benefit of growers who lack specific fertilizer recommendations based upon an analysis of their soil, the general recommendations for tomatoes as outlined in Ontario Bulletin 463 follow:

"In addition to manure add 750 to 1000 pounds 2-12-10 plus 400 pounds of superphosphate per acre. Apply all of the superphosphate and about three-quarters of the complete fertilizer as deeply as possible by use of a grain and fertilizer drill, by deep placement, or by broadcast before plowing. Apply the remaining quarter with the tomato planter. Nitrogen analyses higher than 2 percent are not recommended except on the basis of a soil test, owing to the danger of late maturity and blight.

"To prevent fall starvation and to insure ripening of the crop side-dress at the time of the last cultivation with approximately 100 pounds per acre of muriate of potash. An additional application of 100 pounds ammonium nitrate per acre may be applied at the same time where poor growth or excessive rainfall indicate a need."

CULTURAL FACTORS IN CROP PRODUCTION

It is difficult to single out one or two factors which have contributed to success in the production of field tomatoes. Each factor represents a link in the chain leading to success. However, it is usually a relatively easy task to single out one or more factors which have contributed to, or been responsible for, crop failure. Many of these factors are cultural and therefore within the control of the grower.

DATE FOR FIELD SETTING

The tomato is a heat-loving plant and also requires a relatively long growing-season. Therefore, advantage must be taken of the entire frost-free period by setting plants in the field as early as possible after danger from frost is past — provided of course that the land has been properly fitted. It is considered that there is a yield loss of as much as one ton of tomatoes per acre for each week that planting is delayed. The necessity for early land-preparation and for early field-setting serves to emphasize the need for using only land which is well drained, and for using only well-grown, suitably hardened plants capable of withstanding adverse weather conditions.

PLANTING DISTANCE

The varieties of tomatoes currently used for processing in Ontario require a minimum of 16 sq. ft. per plant. Many growers have found that 18 sq. ft. per plant is not excessive.

The recommended spacing for plants in the field is 5 to 6 feet between the rows, and sufficient space between plants in the row to provide a minimum of 16 sq. ft. In Southwestern Ontario, where cross cultivation is not practised and where the acreage of the less-vigorous varieties is on the increase, plants are being set as close as 2½ feet in the row. When custom spraying is planned it is essential that all fields to be sprayed with any given machine be planted with rows spaced the same distance apart. While many growers still follow the old practice of setting plants 4 by 4 feet, the wider row-spacing is becoming increasingly popular. Wider spacing reduces the hazard from early development of disease by giving the sun and the breeze a greater opportunity to dry the foliage following a heavy dew or a rain. The wider spacing also facilitates the efficient application of fungicides, and the harvesting of the crop.

CARE OF PLANTS

Plants should be transplanted as soon as possible after leaving the nursery. When plants must be held they should be kept in a cool place. Bundles of pulled plants should be opened and stood upright on a cool, moist floor. As a precaution against disease avoid wetting plant stems and leaves. Plants delivered to contract growers in flats should be set in a sheltered place and protected against prolonged periods of cold, wet weather, owing to the possible danger of disease development. To avoid excessive hardening, plants should be watered from time to time as required.

In Eastern Ontario it is common practice for contract growers literally to stampede plant growers for their plants the first day that plants are made available. Two reasons seem to be responsible for this.

(1) Fear that otherwise they will not get choice of good plants.

(2) A belief that plants must be hardened for a week or two prior to being set in the field.

Both of these reasons have some basis in fact owing to the existing plant situation. Most growers would, however, have better plants if they called for them when their land was ready for planting. Too many plants are, in the name of being hardened, so abused by neglect that they often require from 10 to 14 days to recover after being set in the field.

Tray-grown plants will be better able to withstand transplanting if the flats are watered with transplanting solution a few hours before the plants are lifted. When removing plants from the flat it is well to loosen the soil and to flip both soil and plants onto the ground. Plants may then be separated with less root destruction than would be the case if they were lifted directly out of the flat.

Another precaution often neglected by growers is to protect the roots from the sun and from drying winds during the transplanting operation.

FIG. 4. Plants must be good if yields are to be high.

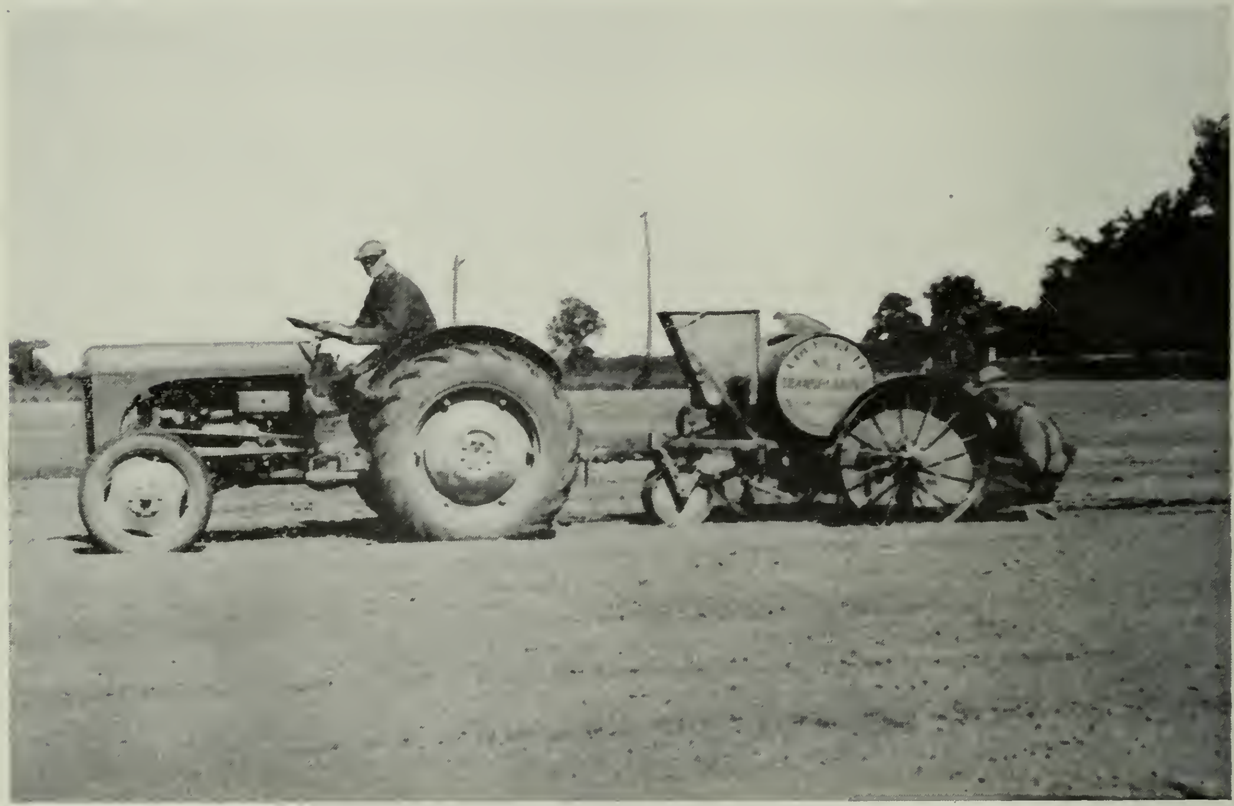


FIG. 5. Transplanters offer a fast, efficient, and economical method for setting plants. Also they make it possible to apply both fertilizer solution (page 21) and dry fertilizer (page 18).

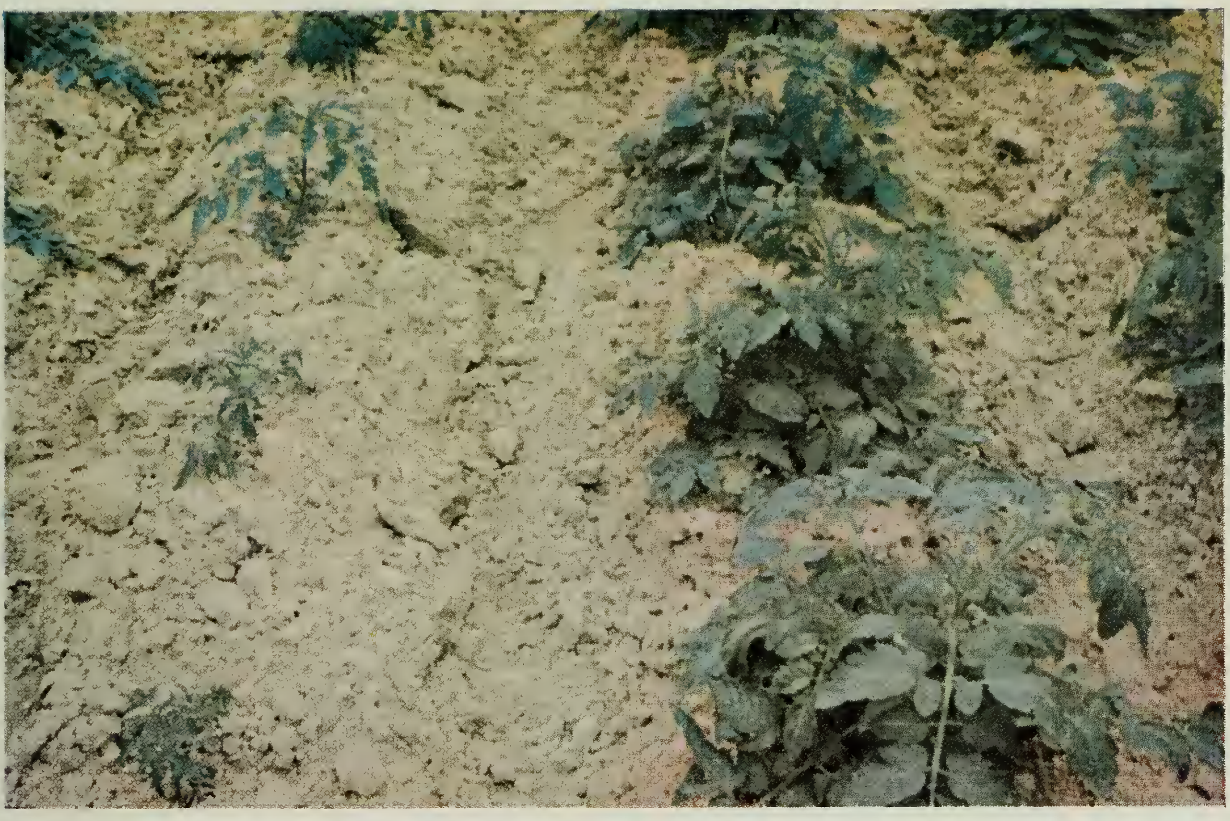


FIG. 6. Transplanting solutions, by providing readily available nutrients, stimulate root development thereby assisting young plants to withstand shock and to become quickly established in their new environment. Plants at right received transplanting solution. Plants at left received water only.

TRANSPLANTING SOLUTION

The shock suffered by tomato plants when removed from the shelter of the nursery and transplanted into the field is very considerable. Transplanting solution, by providing readily available nutrients, when and where they are most needed, stimulates root development thereby assisting young plants to withstand shock and to become established in their new environment. This, in turn, will promote earlier maturity and heavier yield, both important considerations.

The advantages of using a transplanting solution, also known as booster or starter solution, are no longer subject to question. Increased yields of as much as one ton of tomatoes per acre are not unusual. Transplanting solution should not, however, be expected to overcome the adverse effects of setting poorly grown plants, or of setting plants in poorly drained land, or in land which has not been properly fitted.

Growers sometimes neglect to use transplanting solution, or even water, in their transplanters believing the soil to have ample moisture. Actually, if a soil is too wet to use transplanting solution it is too wet to transplant tomatoes.

When booster or transplanter fertilizers were first introduced trouble was often experienced owing to the insoluble portion plugging the water lines of the transplanter. This necessitated the preparation of a stock solution by suspending a bag of fertilizer in water, and then discarding the insoluble portion which remained in the bag. The introduction of completely soluble forms has eliminated this difficulty. The required quantity of starter is merely dissolved and then added to the water in the barrel on the transplanter.

In addition to the incompletely soluble and the completely soluble forms, transplanter or starter fertilizers may be purchased in liquid form. While this

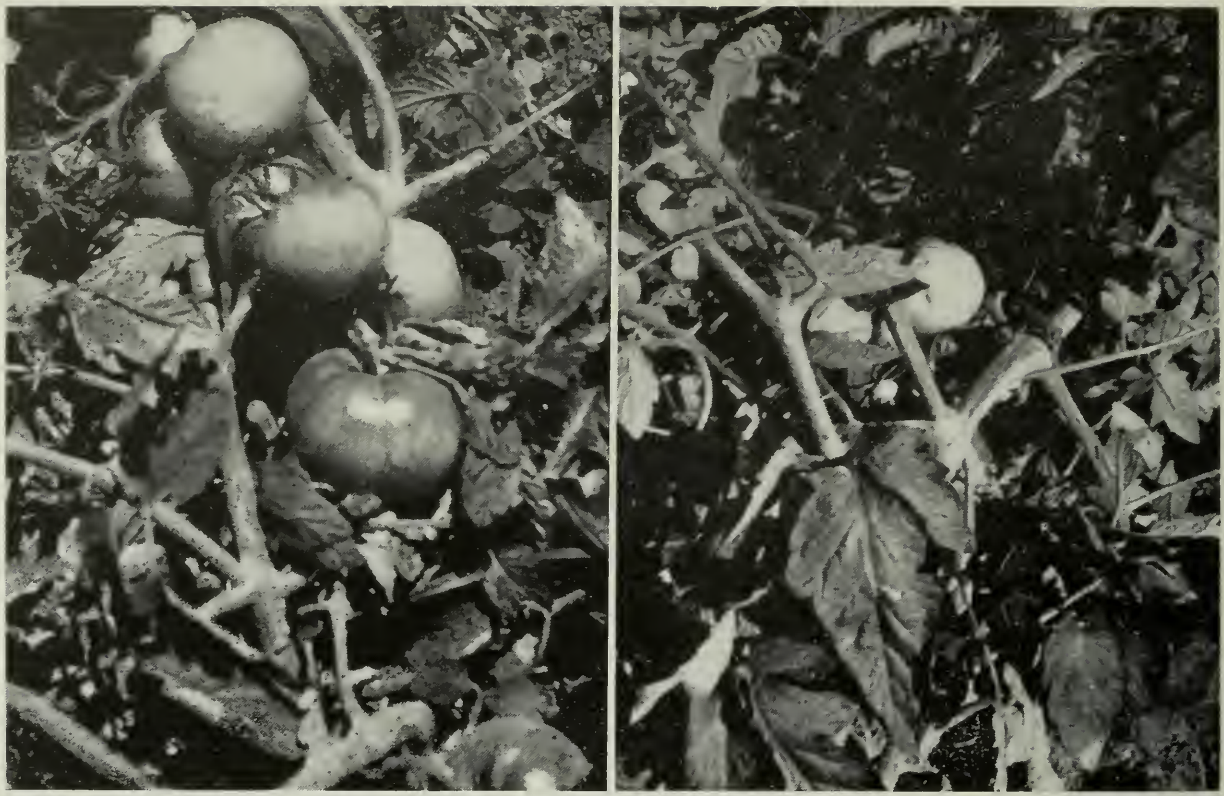


FIG. 7. The influence of transplanting solution upon early set of fruit is clearly indicated. Plant at left received transplanting solution. Plant at right did not.

form is certainly more convenient to use than the incompletely soluble form, it is, on the basis of plant-food content, the most costly to use.

Starters presently on the market, when used according to manufacturer's directions, provide quite a wide range of total nutrients. While information is lacking in respect to what the optimum or top range should be, it is considered that the lower range is inadequate.

To compare the relative fertilizer cost in the case of the three forms of starters a sufficient amount of each must be used to provide a comparable quantity of total nutrients. For example, to apply 13.4 pounds per acre of total nutrients (nitrogen, phosphoric acid, and potash) relative costs for plant food would be as follows: incompletely soluble, approximately $2.00 per acre; completely soluble, $4.00 to $6.50 per acre; liquid, $20.00 to $22.00 per acre.

FIELD SETTING

Plants are subjected to a severe check when transplanted even under favorable conditions. Anything which can be done to assist in their re-establishment will be reflected in early plant development and in increased early yield. Toward this end, good plants should be carefully handled and carefully set in well-prepared land as early as it is reasonably safe to do so.

While early field-setting is important, plants should not be transplanted before the land has been properly fitted. No amount of after cultivation will overcome the adverse effects of setting plants into land which has been improperly or inadequately prepared. Set a few days later, *if necessary*, but set plants in well-prepared land.

Plants will have a better opportunity to become established if, during periods of bright, hot weather, transplanting is done during the late afternoon and evening.

Mechanical transplanters are now in general use for the setting of processing tomatoes. However, in Eastern Ontario a portion of the acreage is still set by hand. Machine-setting is faster, more economical and, in the hands of careful operators, more efficient. Machine-setting offers the further advantage over hand-setting that plants can be set, watered-in with transplanting solution, and the split application of fertilizer applied where it is needed, all in one operation.

Production operations which involve the use of farm machinery will be speeded up and the destruction of plants and fruits will be reduced if a generous headland is provided all around the field and if the rows run the long way of the field. Roadways to facilitate harvesting should be provided at planting time. This is usually accomplished by leaving unplanted one row in sixteen. Roadways may, however, be spaced to suit the convenience of sprayers or other farm implements. It is recommended that no plants be set in the roadways since a saving of plants is effected and much of the fruit produced in this row would be damaged. A ten- or twelve-foot roadway will, owing to plant growth, be reduced to six or eight feet by harvest time.

The provision of a generous roadway offers many advantages and these become even more apparent at harvest time. The practice of opening roadways by rolling plants back, renders efficient spraying difficult at best. The lowered grade occasioned through exposure of fruit, the higher incidence of disease, and plant and fruit destruction in rows straddled by trucks and tractors, further supports the recommendation to leave roadways unplanted.

Plants should be set deeply. As much as 4½ inches of the plant, which in some cases may be half its total length, should be set into the soil. Air-spaces should be eliminated by firming the soil at root level, not at ground level which simply "chokes" the plant.

Time spent in adjusting and repairing the transplanter well in advance of the planting season will avoid delays and result in more efficient work. Field setting is often delayed many days and the reworking of land necessitated, owing to rain, simply because of delays and break-downs which could and should have been avoided.

In Eastern Ontario weeds present a problem for growers of processing tomatoes. Check planting, which enables the crop to be cultivated both ways, is therefore the accepted method of culture in this area. Even where plants are set by machine the land is rolled and marked in advance so that plants may be set on the check marks.

CULTIVATION AND WEED CONTROL

Field tomatoes are cultivated for three reasons:

1. To loosen up soil which has become compacted, thereby conditioning it to receive and to absorb rainfall.
2. To supply soil micro-organisms with air so that they may thrive and liberate plant food for the crop.
3. To control weeds.

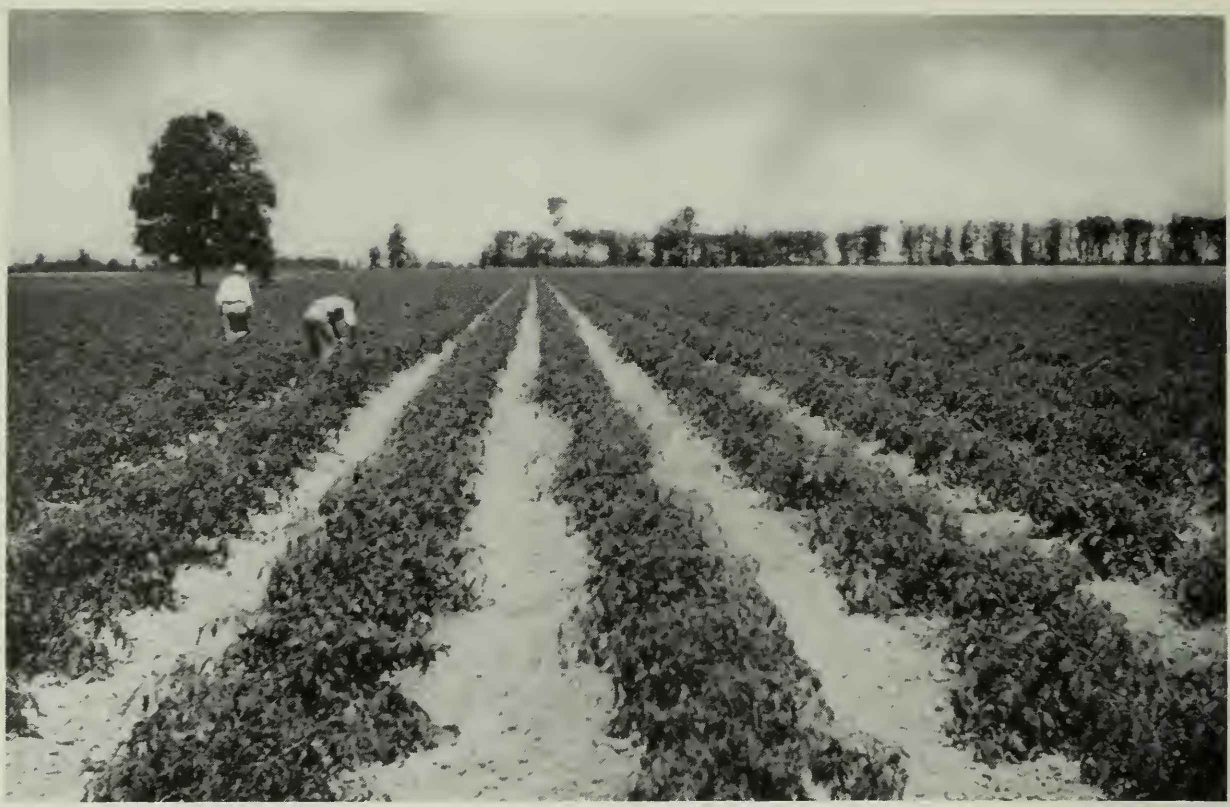


FIG. 8. Cultivation at this stage of development reduces crop yield through the destruction of plant roots. Use a hoe to control the few weeds which may become troublesome.

Soils do become compacted during the transplanting operation. It is desirable therefore to cultivate deeply immediately after field setting and to go as close to the plants as possible without uprooting them. Subsequent cultivation should be shallow and increasingly farther removed from the plants. The cultivation of soil towards the plants, as in hilling, is beneficial in three ways:

1. Many small weeds close to the plant and in the plant row will be smothered.
2. Tomato plants will develop roots farther up the stem.
3. Surplus moisture will not collect under tomato plants where it encourages disease, but tends to run away from the plants and to collect between the rows.

Ontario Bulletin 463 "Soil Management and Fertilizer Use" has this to say in respect to tillage in general.

"The purpose of cultivation is to prepare a seedbed, to lessen weed competition for moisture and plant nutrients, and to incorporate manures and other crop refuse. Cultivation speeds the decay of organic matter — a "stoking the furnace" process which should be recognized as such. The heavier the stoking to release plantfood and promote crop growth, the more "fuel" or organic matter must be added.

"Frequent cultivation may so deplete organic matter that the soil's water-holding capacity is materially impaired. This is just as important for the cereal crops as it is for the more intensive fruit, vegetable, and hoed crops. It was once thought that cultivation conserved moisture. Actually cultivation conserves moisture only in-so-far as it removes competing weeds or cover crops. Therefore the cultivation of a weed- or plant-free soil does not conserve moisture in any appreciable degree. Nor does it promote the upward movement of water from the subsoil, or distribution sideways. Frequent and deep stirring of soil may in fact speed up water losses by exposing fresh amounts of moist soil. Also, the impairment of soil structure from unnecessary cultivation may be of more importance than moderate weed competition.

"Reduce cultivation to a minimum for the soil type, the crop, and the conditions. If one or two cultivations serve the purpose then more are an unnecessary expense, and only increase the loss of organic matter, impair soil structure, and lower soil moisture.

"Depth of cultivation is also of prime importance. The deeper the cultivation, the more active the destruction of organic matter, and the faster soil structure is destroyed. Also, injury to shallow-rooted crops may occur by the cutting of feeder roots near the surface.

"In short, while tillage is essential for many crops, we must recognize that, the more soil is cultivated, the greater its loss of structure, the less fertile it becomes, the more tillage it requires to maintain production, and the less effective tillage becomes."

WATER REQUIREMENTS

Lack of sufficient moisture is frequently the limiting factor in crop production. This is particularly so in Eastern Ontario where crop losses and crop failures attributable to inadequate moisture occur all too frequently. The development of blossom-end rot in such crops is usually an indication of lack of sufficient moisture.

Normal precipitation during the summer months is not sufficient for crop needs. Moisture stored in the soil is drawn upon by plants to supplement that which falls as rain. When, owing to the shallow nature of a soil or to an inadequate supply of organic matter, soil reserves of moisture are not adequate, the crop suffers. A few tomato growers are using irrigation with good results. Others who are favorably situated with respect to a suitable supply of water might well consider irrigation.

DEFOLIATION

An increasing number of inquiries are received each year seeking information relative to the use of plant defoliants on tomatoes. Defoliants are used on crops such as cotton and potatoes to facilitate harvesting, and in the case of potatoes to reduce disease. Unlike these crops, however, tomatoes are not all harvested at one time, rather the harvest is progressive often extending over a period of several weeks. The defoliation of a tomato crop other than just prior to the last picking might result in a greatly reduced yield. Moreover, if bright hot weather prevails following defoliation, losses owing to sunscald and the development of leather top can be expected.

The writers have yet to see conclusive evidence to show that defoliation of tomatoes is beneficial. In instances where late blight threatened to ruin a crop it might be possible to salvage some of the fruit following defoliation. Such a condition should not arise, however, where acreage has been thoroughly sprayed with approved fungicides. A heavy growth of vine occasionally develops owing to an excess of nitrogen becoming available late in the season. Under such circumstances fruit is difficult to see and the harvest may be slowed down to a point where pickers find it difficult to make satisfactory wages. Partial defoliation by Aero Cyanamid, Special Grade, in instances of this nature would possibly be worthwhile. The advantage, however, is considered to be one of facilitating the harvest rather than one of hastening maturity through exposure of fruit.

The leaves are the manufacturing organs of the plant, and a normal, healthy foliage is necessary to develop and to mature the crop. Foliage cover is also closely associated with the development of good, red colour in the fruit.

INSECTS AFFECTING TOMATOES

The principal insects which attack field tomatoes are cutworms, flea beetles, aphids, hornworms, grasshoppers and wireworms. With the possible exception of cutworms none of these insects is usually troublesome in all tomato producing areas. Regionally, however, injury may be sufficient to justify control measures.

The following brief notes are intended to assist in identifying these insects so that, when required, the correct control measures can be applied. Recommended control measures for 1952 will be found on page 27. For control measures in subsequent years consult the current issue of the Ontario Vegetable Protection Calendar.

Aphids. These soft-bodied insects, which suck plant juices, are usually found on the underside of leaves. Aphids are often called plant lice. When plants are small and insects numerous injury may be sufficient to retard development. The greatest injury, however, is through the spread of virus diseases, particularly cucumber mosaic, from weeds and other plants to tomatoes.

Cutworms. Newly set tomato plants are often cut off at or near ground-level by smooth, plump caterpillars Cutworms feed during the night and, during the day, hide just below the surface of the soil.

Flea Beetles. These small, jet-black beetles, which are about pin-head in size, eat small circular holes through leaves of newly transplanted tomatoes. Injury may be severe enough to defoliate plants and retard growth. Beetles jump when disturbed.

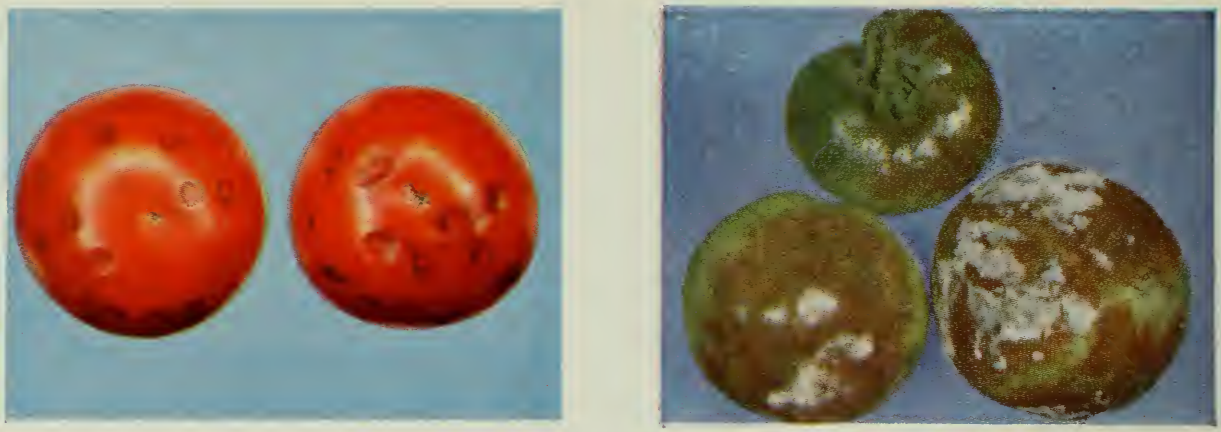
Grasshoppers. Occasionally when food is scarce during a dry period, grasshoppers migrate from adjoining road allowances, headlands, or sod crops to tomato fields where they eat both leaves and fruit.

Hornworms. The tomato hornworm is a green caterpillar which is easily recognized by characteristic V-shaped markings on the sides, and a large horn on one end. When fully grown, caterpillars may be four inches long and nearly one-half inch in diameter. If not controlled one or two hornworms may defoliate an entire plant.

Wireworms. Wireworms, the slender, cylindrical larvae of the click beetle, infest the soil and attack plant roots. They may be yellow, straw-coloured, or reddish brown in colour.

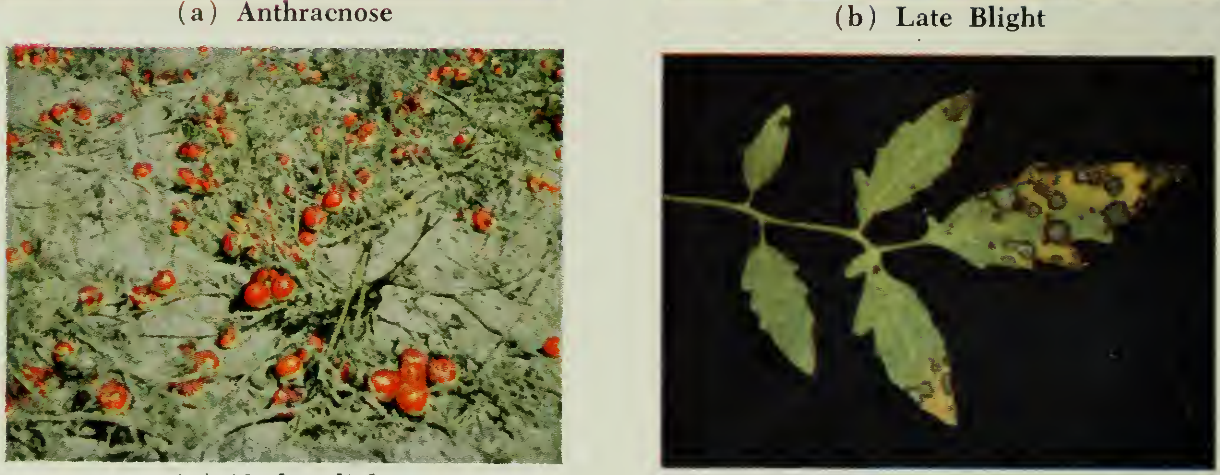
1952 RECOMMENDATIONS FOR TOMATO INSECT CONTROL

INSECT	SPRAY	DUST	REMARKS
Aphids	Nicotine sulphate 1¼ pt. per 100 gal.	3% Nicotine dust 30 to 40 lb. per acre.	Nicotine sulphate may be applied with regular sprays in schedule. If applied as a separate spray add 3 to 5 lb. of dissolved laundry soap to the nicotine sulphate. Apply on calm day when temperature is above 70°F.
Cutworms	Use poisoned bait; bran 25 lb., paris green 1 lb., water to moisten, about 2½ gal. Use 15 lb. per acre if broadcast before transplanting. After transplanting apply teaspoonful near to, but not touching, each plant.		Mix bran and poison, then add water slowly to mixture while stirring. Apply bait early in evening after a warm day.
Flea Beetles	DDT 50% wettable 2 lb. in water 100 gal.	3% DDT 30 to 40 lb. per acre.	Use only preparations specified for tomatoes. Owing to possible injury repeat only when necessary.
Hornworms	DDT 50% wettable 2 lb., or calcium arsenate 2½ lb., or lead arsenate 5 lb. in water 100 gal. in each case.		Poison may be added to regular spray (or dust) schedule. Repeat application if necessary. Hornworms are most easily killed when small. Do not use insecticide after fruit commences to ripen.
Grasshoppers	Chlordane 50% wettable 2½ lb. in water 100 gal. Apply at rate 80 gal. per acre.	5% Chlordane at rate 20 lb. per acre.	Do not apply chlordane on pastures or on crops where forage is to be fed to livestock, or on edible parts within one month of harvest. Apply spray or dust only along margins of fields, road allowances and waste land, to check insect migration to tomato fields. Control in tomato fields is much more difficult.
	Use poisoned bait; bran 25 lb., paris green 1 lb., water to moisten, about 2½ gal. White arsenic 1 lb., sodium arsenite ½ pt. or sodium fluosilicate 1 lb. may be substituted for paris green.		Apply in the morning of a warm, sunny day. Baiting is not effective after migration commences.
Wireworms	Chlordane 40% wettable Follow manufacturer's directions.	5% chlordane.	½ lb. 40% chlordane wettable powder added to 40 gal. transplanting solution is a cheap and easy method of application. Avoid setting tomatoes on land known to be infested with wireworms. Old sod land is likely to be infested. Beets, carrots and potatoes should not be planted on land within two years of treatment with chlordane.



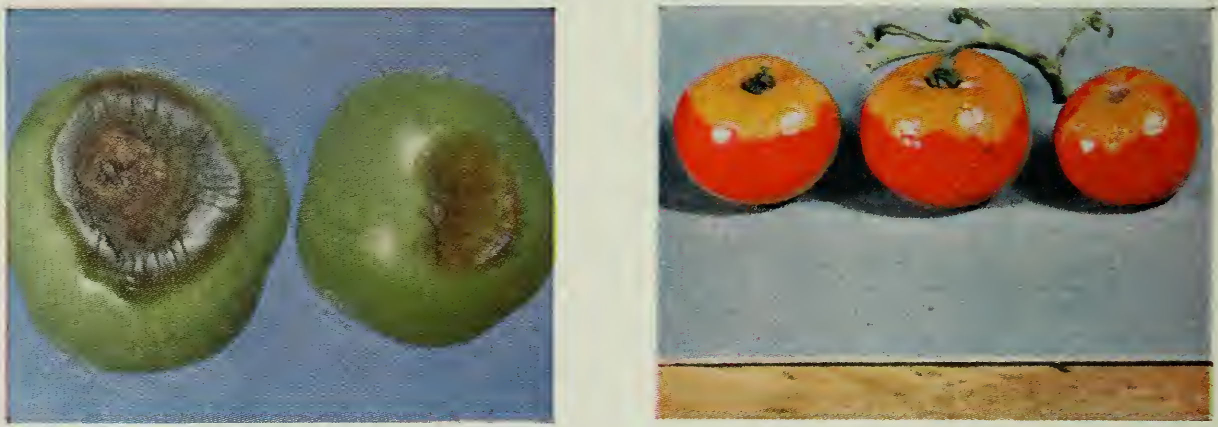
(a) Anthracnose

(b) Late Blight



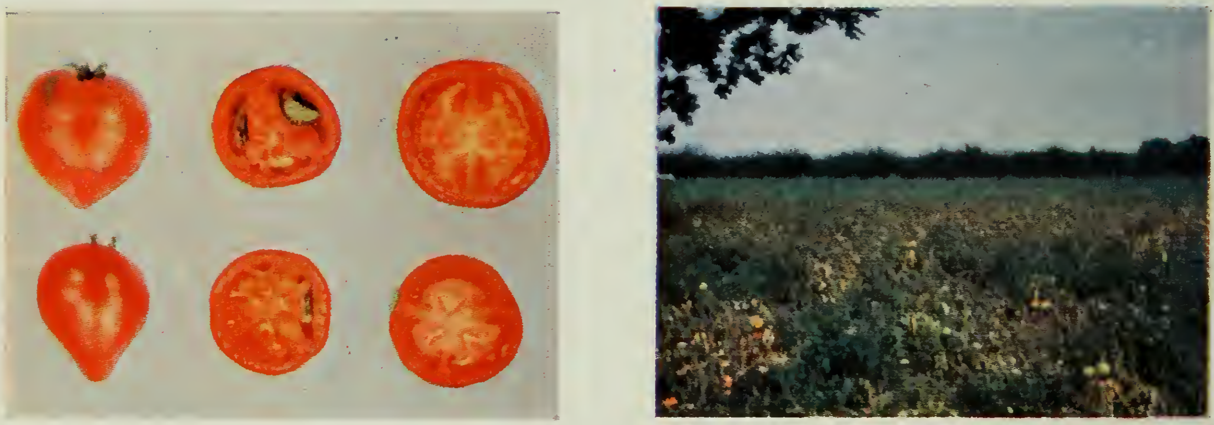
(c) Early Blight

(d) Septoria Leaf Spot



(e) Blossom-end Rot

(f) Leather or Yellow Top



(g) 2,4-D Injury

(h) Walnut Wilt

FIG. 9. Most tomato diseases can be recognized by their symptoms. Some are illustrated above.

DISEASES AFFECTING TOMATOES

Effective control of disease has become of major importance in the production of processing tomatoes. While the crop has been grown in Ontario for many years with little or no thought to disease control, and while spectacular field losses have occurred only at infrequent intervals, growers have been subjected to annual losses in yield and grade substantially greater than they realized. In recent years these losses have been steadily increasing owing to the build up, in tomato soils, of the fungus which causes anthracnose, and owing to increasing losses from late blight.

Tomato diseases are of two general types, parasitic and non-parasitic. Parasitic diseases result from the invasion of plant tissue by fungi or bacteria, or from the presence of one or more viruses in the juices of infected plants. While their exact cause, in some instances, is not as yet clearly understood, non-parasitic diseases are generally attributed to faulty environment such as nutrient deficiencies, to irregular moisture supply, to exposure of fruit to the sun, to fumes or spray of 2,4-D, and, in the case of walnut wilt, to a toxic substance.

Diseases of the non-parasitic group are not infectious and do not normally present a problem where tomatoes are efficiently produced. In contrast, virus diseases are highly infectious; and those caused by fungi and bacteria can spread with amazing rapidity under conditions favorable for their development.

The principal diseases, parasitic and non-parasitic, affecting field tomatoes in Ontario, with a brief description in each case, are as follows:

PARASITIC DISEASES

Anthracnose. The fungus *Colletotrichum phomoides* which causes anthracnose survives from year to year on decaying organic matter in the soil. It is now generally distributed throughout the tomato producing areas of Ontario. Injury is confined almost exclusively to the ripe fruit, on which circular, sunken spots develop ranging in size from pin head to 1½ inches in diameter or more. Infection may take place as early as mid-July when fruits are quite small. Spots do not, however, become visible until the fruit turns red in colour. The development and spread of anthracnose is favored by warm, wet weather.

Anthracnose is considered by some authorities to be an important source of mould count in processed tomato products. Owing to the fact that spots or lesions develop very rapidly even after the fruit has been picked, a small amount of infection at harvest time can be serious. As little as 10 to 15 per cent infection may mean a crop failure owing to the prohibitive cost of salvaging sound fruit. Crop rotation may be helpful in reducing infection but a spray program is essential for effective control. For spray recommendations see page 35.

Early Blight. The fungus *Alternaria solani* which causes early blight of tomatoes also attacks potatoes. While all parts of the tomato plant may be affected, injury is most commonly observed in the plant nursery as damping-off or collar rot; on the leaves which are often severely defoliated early in the season; on the stems as dark elongated blotches; and on the fruit where rot develops near the point of stem attachment, and in wounds such as cracks. Early defoliation is often accompanied by a loss of blossom with consequent reduction in yield. The dark brown to black leaf spots are irregular in shape but are usually recognizable by the presence of concentric rings resembling target spots. These develop as the spots enlarge.

The fungus survives from season to season on crop refuse in the soil. It thrives during cool weather and often appears on field crops early in the season. While occasional crops have been observed in which rotting was so severe as to render harvesting uneconomic, injury from early blight generally takes the form of reduced yields owing to defoliation, loss of blossom, and lowered grades, the latter attributable to leather top, sunscald, and fruit-rot.

Crop rotation, though important, can only be depended upon to delay development of the disease since the spores by which the disease is spread are air-borne.

Early blight can be controlled by a spray program. See page 35. Measures for the control of this disease should, however, commence in the plant nursery and be continued in the field.

Late Blight. The fungus *Phytophthora infestans* which causes late blight of tomatoes survives only on living tissues. Since the fungus is the same as that which causes late blight and rot of potatoes a frequent source of infection is by wind-blown spores from adjacent or nearby infected potato crops or dumps. Since the fungus can, and usually does, overwinter in the southern United States, owing to the mild winters which prevail in that area, tomato transplants shipped from the south sometimes contain diseased plants. In Ontario, late blight may also survive the winter on greenhouse tomato crops. Tomato seedlings and plants produced in such houses constitute a possible source of infection for the field crop.

The severity of loss in the field is usually dependent upon weather conditions. Cool, moist, foggy weather favours the development and spread of spores. Under slightly higher temperatures spore production is slowed up but the fungus continues to live and to develop within the tissues of affected plants. Bright, hot, dry weather serves to arrest the spread of late blight by discouraging the development of spores and by destroying many of those which were produced under more humid conditions.

On the leaves dark watersoaked areas develop. Under humid conditions leaf spots show a characteristic lighter margin or halo. Affected spots on stems may enlarge until the branch is girdled causing the entire leaf or branch to droop and die. Severely attacked crops look as though a frost or flames from a blow torch had struck them. Late blight is usually first seen on the foliage but cases have been observed where the first truss of fruit has been rotted before visible leaf spots were observed. Under moist conditions, a sparse, white, downy growth usually develops on the under-side of affected leaves and on diseased fruit. On the fruit late blight causes a wrinkling of the skin followed by a rotted condition which can spread with amazing rapidity. Late blight can be effectively controlled by spraying. See page 35.

Septoria Leaf Spot. In Ontario this disease is one of the major causes of defoliation in field tomatoes. The fungus *Septoria lycopersici* which causes the disease lives over winter on tomato refuse and on certain weeds such as horse nettle, nightshade, ground cherry and jimson weed. The fungus thrives under cool, moist conditions and is therefore not so serious during seasons characterized by hot, dry weather.

On the leaves and stems Septoria leaf spot is recognized by dark-bordered, smallish gray spots which have dark specks in the centre. While Septoria leaf spot is occasionally a serious cause of defoliation in plant beds where excessive moisture and inadequate ventilation prevail, it is a common cause of defoliation in unsprayed or poorly sprayed field crops. The fungus develops first at the centre of the plant where foliage cover helps to hold moisture. Septoria is spread from leaf to leaf and from plant to plant by reproductive bodies called spores which drip or are splashed about during moist or wet weather. Diseased leaves wither and drop off. Defoliation spreads progressively from the centre of the plant to the tips of the branches. Loss of foliage exposes fruit to the sun, and leather top and sunscald often develop. Immature fruits do not develop or mature normally. The loss in yield is influenced by the earliness and the severity of the attack. For recommended spray program see page 35.

Tomato (Tobacco) Mosaic. The virus which causes this mosaic attacks tobacco and a wide range of ornamental and vegetable plants such as petunia, snapdragon, pepper and eggplant. Two forms of mosaic may be caused by the tomato mosaic virus. In the case of the common or green tomato mosaic the leaves show a light- to dark-green mottling which, depending upon the time of infection, may or may not be accompanied by stunting and leaf distortion. If infection takes place after the crop has set no serious reduction in yield may be observed. The yellow form of tomato mosaic is much more striking since the leaves and often the stems and fruit show a distinct yellowing. Affected plants are dwarfed and foliage is deformed.

Infection can take place at any time in the life of the plant and from many sources. The most common source of infection is through the transference of plant juices from infected to non-infected plants in the nursery and during transplanting operations. Another source of infection is through workers who use tobacco. To avoid infection of tomato plants workers should wash their hands thoroughly with soap and water after handling either smoking or chewing tobacco. Mosaic is frequently spread from infected to non-infected plants in the field by farm implements such as cultivators, and by workers brushing against the plants. In the field several plants in a row are often observed to be affected by mosaic. This type of infection can be, and usually is, caused by workers on the transplanter, whose hands become infected when handling diseased tomato plants. Infection is then spread to other plants as they are set in the field. A further spread of infection in the row can be attributed to cultivation.

Cucumber Mosaic. The virus which causes this form of mosaic attacks vine crops such as cucumbers and melons and certain native weeds like catnip, motherwort, plantain, pokeweed and *Physalis spp.* Plant lice or aphids are primarily responsible for the spread of this virus. On tomatoes, cucumber mosaic causes the foliage to develop in a characteristic shoe-string fashion, the injury in the early stages resembling that caused by 2,4-D. Measures for the control of this disease include the control of aphids, when present, and the elimination of weeds, especially those known to harbor cucumber mosaic, from the proximity of plant-growing establishments.

Streak. Two types of streak are known to attack tomatoes in Ontario. In one case streak is caused by a single virus, while the other type of streak is caused by a mixture of viruses. In Ontario the mixed virus streak is generally attributed to infection by potato and by certain strains of the tomato and cucumber mosaic.

Infected plants are stunted and foliage is mottled and distorted. On stems and leaves streaks of darkened tissue develop. On the fruits, spots are somewhat irregular in shape and greasy to the touch. Under field conditions seldom more than a few plants become severely infected, as contrasted to staked and greenhouse crops where pruning and tying of plants may cause a general infection.

NON-PARASITIC DISEASES

Since non-parasitic diseases are attributed to adverse environmental influences their causes usually suggest appropriate control measures. In general, growers can, by exercising care in respect to land choice and cultural practices, avoid or minimize losses. In the case of lightning no control measures are suggested for obvious reasons.

Blossom-end Rot. Usually observed about mid-August when the first fruits approach marketable size. Diseased fruits develop a flattened appearance owing to the shrinking of tissues in the lower half of the fruit. Affected portions become grey to dark in colour, leathery in texture, and, if invaded by fungi, the fruit may rot.

Blossom-end rot is caused by insufficient moisture while the fruit is developing. It is usually worse on shallow soils and in seasons of insufficient rainfall especially along fence lines where tree roots compete with the crop for available moisture. Blossom-end rot may be caused indirectly by excessive moisture early in the season restricting root development and thereby limiting the ability of plants to later reach out for moisture. Vigorous-growing crops on light-textured soils low in organic matter are often severely affected.

Leather or Yellow Top. The outside wall on the top portion of the maturing fruit develops a tough, leathery texture which is yellow in colour. Production in processing plants may be lowered to uneconomic levels when this condition is severe since the affected portion must usually be removed by hand labour.

Leather top is generally worse in crops which have an inadequate foliage cover whether caused by lack of growth, or owing to defoliation by disease. Lack of sufficient potash is considered by some to be associated with the development of this condition. In Ontario, leather top seems to be serious only where insufficient foliage is present to protect the fruit. Uniform-ripening varieties, i.e. those whose immature fruit is characterized by pale-green shoulders, are not subject to this condition.

Lightning. Almost every year at least one tomato field in the province is struck by lightning. Affected areas vary in size but upwards of 100 plants, or more, may be involved. Most plants in affected areas are killed. Around the margin of the areas, however, only parts of plants may be affected.

Sunscald. Tomato fruits which are exposed to the direct rays of the sun often develop a tough, whitish spot on the exposed cheek. The grade of such fruits is substantially reduced not only because of disfigurement and shrinkage but often owing to rots caused by micro-organisms which enter the fruit through the injury. While varieties having sparse foliage are more subject to sunscald, the injury is frequently observed where plants have been defoliated by such diseases as early blight and Septoria leaf spot.

Walnut Wilt. A wilt caused by a toxic substance in black walnut, has been observed in Central and Western Ontario where tomatoes have been planted in areas occupied by roots of this species of tree. Tomato plants seem to develop normally for a period of 4 to 6 weeks following field setting, then wilt and die. Owing to the fact that the toxic substance persists in the roots and the nuts of black walnut until they are completely decayed, tomato plants should not be set in close proximity to fence lines in which this species of tree is growing nor on land from which black walnuts have been removed.

2,4-D Injury on Tomatoes. Tomato plants are very susceptible to 2,4-D. An imperceptible drift from 2,4-D spraying operations along fence lines or road allowances, or even fumes from some forms of 2,4-D, may cause injury to, or death of, tomato plants. Injury from 2,4-D is recognized by a characteristic abnormal development, new growth having a distorted or shoe-string appearance. Foliage injured by 2,4-D resembles that affected by the cucumber mosaic virus. Observations made on a number of affected tomato crops indicate that blossoms subjected to some forms of 2,4-D injury may not set, that seed development in injured fruits is arrested, and that severely affected fruits are often distinctly pointed. A darkening of internal tissues in the case of many first-ripened fruits has also been observed in severely affected crops, and this is believed to be associated with 2,4-D injury. The size and development of the plant at time of exposure to 2,4-D will, no doubt, influence the injury, if any, shown by late-maturing fruit. In the case of several fields observed during the 1951 crop season many late-maturing fruits were not normal in either size or shape.

Extreme care should be exercised where 2,4-D is sprayed in the neighborhood of tomato acreages. Sprayers used for weed control should, under no circumstances, be used for the application of fungicides to tomatoes. In any event such machines lack sufficient pressure for efficient control of tomato diseases. If the injury is not too severe, affected plants usually grow out of it as new foliage develops. This new growth is normal in appearance.

SPRAYING FOR THE CONTROL OF TOMATO DISEASES

The application of fungicides on tomato crops in Ontario is intended principally for the control of the following fungous diseases: anthracnose, early blight, late blight, and Septoria leaf spot. Tomato diseases caused by bacteria are of relatively minor importance.

Certain general information seems fundamental to a proper understanding of what causes these diseases and how they may be controlled. We must, for example, recognize that weather does not cause a fungous disease. Weather merely aids or retards the development of the fungus which causes disease. Moreover, of the thousands of fungi known to man, many are beneficial and only a very few cause tomato diseases.

Each fungous disease is caused by a particular species of fungus, and a fungicide which gives good control of one disease may be worthless or of little value for the control of another. Zineb and copper fungicides, for example, give good control of early blight and late blight, but relatively poor control of anthracnose. Ziram fungicides like Zerlate give satisfactory control of anthracnose but are not effective against late blight. Since it is not possible to predict which disease or diseases will be injurious in any year it is necessary to adopt a spray schedule which will give economical and efficient control of all four troublesome diseases.

Fungicides are protective rather than curative in action. Since fungicides are applied only on external plant surfaces any value which they possess must lie in their ability to kill fungi before these fungi can gain entrance to plant tissue. This fact serves to emphasize the necessity for thoroughness in spraying in order that the plants will be completely covered by a protective layer of fungicide. In this connection it is well to remember that spray materials do wash off and that tomato foliage which develops following the application of one spray is not protected until the next spray has been applied. For this reason, during wet weather, when conditions are favorable for disease development, it may be both

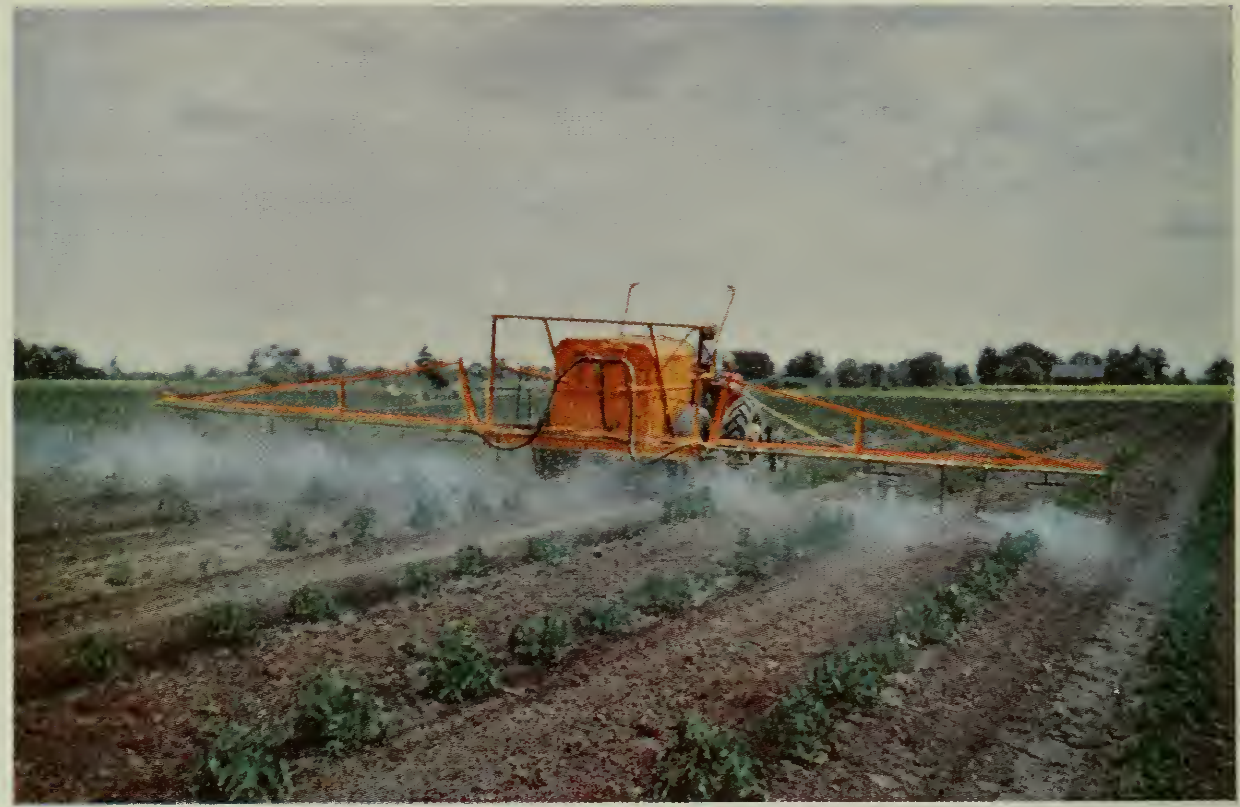


FIG. 10. Sprayers with conventional-type booms give excellent service. This is the type of boom recommended for use in Central and Eastern Ontario where land is often rolling.

desirable and necessary to spray more frequently and, if needed, to add one or more sprays to the schedule. The basic schedule of five sprays spaced at approximately ten-day intervals should, however, be sufficient to give reasonable, commercial control of the troublesome fungous diseases of tomato in most seasons.

Three factors are important in the control of fungous tomato diseases. They are, the use of the correct fungicide or fungicides, the application of fungicides at the proper time, and thorough coverage of all plant surfaces.

Some growers believe that spraying retards maturity. This belief is not supported by either experience or experimental evidence. The recommended spray schedule, when properly and thoroughly applied, increases the yield of marketable fruit, improves the grade, and has no delaying action on maturity. More green tomatoes are, of course, observed on sprayed acreage at the close of the picking season. This is not because of delayed maturity but rather because disease control has encouraged and permitted a heavier set of fruit.

Ontario recommendations for the control of tomato diseases are based upon the use of sprays applied by ground equipment. Fungicides applied in dust form will give a measure of protection but are not considered to be as effective as sprays. Moreover the application of fungicides in dust form by either air or ground equipment presents a problem since the drift of certain fungicides to other crops may cause damage. For instance, copper in spray or dust form is considered to be injurious to peaches, corn and beans.

The planting of tomatoes in young peach orchards is not recommended for two reasons, the danger of damage caused from fungicides containing copper, and the danger from Verticillium wilt, a disease common to both crops. Where

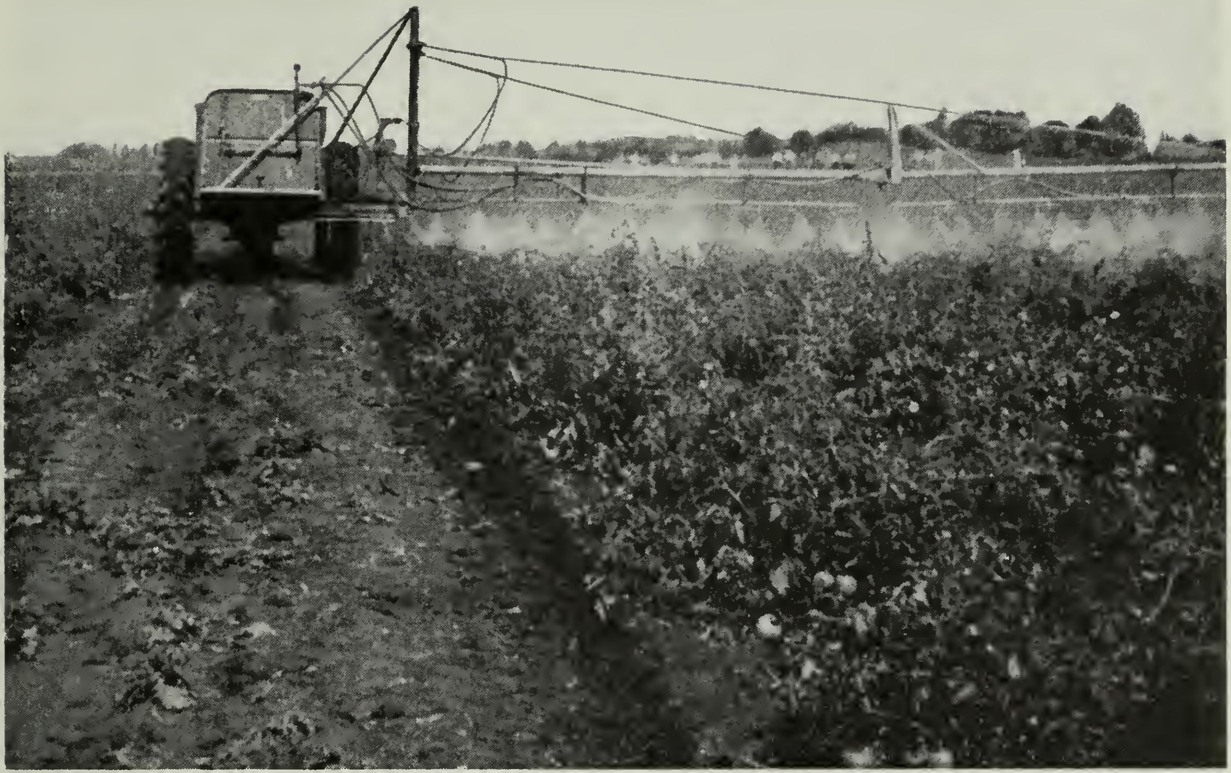


FIG. 11. Sprayers equipped with right-way booms, while heavier than the type illustrated in Fig. 10, are excellent where large acreages are grown on relatively level land. Note that roadway was not planted.

tomatoes have been planted on land occupied by young peach trees extreme care must be exercised to prevent copper sprays, such as fixed coppers and Bordeaux, from coming in contact with peach foliage.

Current recommendations for the control of fungous diseases follow. It is possible and indeed probable that these recommendations will be changed as time goes on in the light of advanced knowledge on the performance and effectiveness of new equipment and fungicides. Consult annual revisions of the Ontario Vegetable Protection Calendar.

SPRAY RECOMMENDATIONS FOR CONTROL OF TOMATO DISEASES, 1952

Diseases Controlled. Anthracnose, Early Blight, Late Blight, Septoria Leaf Spot.

Recommendations. (1) Set only disease-free plants which have been thoroughly sprayed in the nursery with an approved fungicide.

(2) Provide for the application of the recommended five-spray program to field crops.

Recommended Five-spray Schedule. Ziram, Ziram, Fixed Copper, Ziram, Fixed Copper.

If late blight becomes a factor replace fixed copper in the schedule, by Bordeaux. If weather or disease development warrant the application of more than five sprays use a fixed copper or Bordeaux.

Time of Application. Start just before plants "break" or commence to spread over the ground. This is usually the first or second week in July. Apply subsequent sprays at intervals of 10 to 14 days depending upon weather and plant growth. It is difficult to prescribe a specific number of days between sprays. Aim to keep the plants covered, especially just before and during wet, foggy weather, but if possible space sprays so that the fifth is applied in early September.

Rate of Spray Application. 150 to 200 gallons per acre. When plants are small the lesser quantity will suffice. When growth is heavy the greater quantity may be needed.

Pressure. Spray should be applied at from 350 to 450 pounds pressure.

Fungicides. Ziram (zinc carbamate) may be purchased under trade names such as Karbam white, Naugatuck Ziram, Niagara Z-C Spray, and Zerlate. Follow manufacturers' directions.

Fixed coppers may be purchased under such trade names as Basi-cop, Bordow, Coposil, C.O.C.S., Copper-A-Compound, Cuprocide, Cupro-K, and Tricop. Follow manufacturers' directions.

Bordeaux 10-5-100 is prepared from finely powdered bluestone 10 lb., spray lime 5 lb., and water 100 gal. The lime must be fresh each season and must be kept in a dry place. To prepare Bordeaux: Have the agitator running; wash the proper quantity of bluestone through a screen in the hopper while the tank is filling with water, or pour the bluestone slowly into the tank as it is being filled. When about two-thirds of the water has been added pour in the lime slowly and continue filling with water. Keep the mixture agitated while driving to the field. Bordeaux must be used immediately after preparation.

As a guide to growers in calculating the correct quantity of spray materials to use for spray tanks of varying capacities a conversion table, taken from the 1951 Ontario Vegetable Protection Calendar, follows.

CONVERSION TABLE

Amounts of Spray Materials Needed for Various Sizes of Spray Tanks

To make 100 gal.	**1**	**1¼**	**1½**	**2**	**2½**	**3¾**	**5**	**6¼**	**7½**	**10**	**12½**	**15**
To make 40 gal.	⅜	½	⅝	¾	1	1½	2	2½	3	4	5	6
To make 80 gal.	¾	1	1¼	1½	2	3	4	5	6	8	10	12
To make 120 gal.	1⅛	1½	1¾	2¼	3	4½	6	7½	9	12	15	18
To make 160 gal.	1½	2	2½	3	4	6	8	10	12	16	20	24
To make 200 gal.	2	2½	3	3¾	5	7½	10	12½	15	20	25	30
To make 240 gal.	2⅜	3	3½	4½	6	9	12	15	18	24	30	36
To make 280 gal.	2¾	3½	4½	5¼	7	10½	14	17½	21	28	35	42
To make 320 gal.	3⅛	4	5¼	6	8	12	16	20	24	32	40	48

How to Use the Table. Look for the capacity, in Imperial gal., of your spray tank under left-hand column. Supposing your tank holds 160 gal., draw a line under 160 right across the table. To make up a tank of Bordeaux 10-5-100 look along the top row of figures (bold type) for the figure 10. Follow down this column until the figure 16 is reached at the underline opposite 160. This is the quantity of bluestone required for 160 gal. Bordeaux. The quantity of spray lime to use is determined in the same manner, and in this case would be 8 lb. for 160 gal. Bordeaux spray.

Some spray tanks, when full, hold more water or spray than the rated capacity. It is well to take this into consideration when preparing sprays.

HARVESTING TOMATOES

The pay-off on the season's effort comes at time of harvest. Many growers, however, fail to realize maximum returns from their crops owing to the manner in which the harvesting operations are carried out. Also we must recognize the fact that there is no known processing method whereby the quality of raw produce can be improved. Quality fruit must, therefore, be produced in the field and delivered to the factory.

The processor in turn must aim to retain the fullest measure of that quality in the finished product. Many processors could improve the quality of their packs, reduce processing costs and at the same time improve their grower relations by instituting, in the field at harvest time, an educational program designed to show growers and pickers the types of fruit which can and cannot be processed to advantage. Growers and pickers could advantageously be invited to visit processing plants more frequently to see for themselves that cull fruits not only are worthless to the processor but are often costly to eliminate.

COLOUR

Colour is one of the most important attributes of quality in tomatoes and this fact has been recognized in the establishment of grade standards for both raw produce and processed tomato products. Many growers, either through lack of an appreciation of the importance of colour or through indifference, harvest their tomatoes before they are red ripe believing that they will be mature by the time they are processed. Such growers stand to lose not only through lowered grades, but in tonnage as well. Tomatoes increase in weight until they are red ripe, and commence to lose weight immediately they are harvested. The loss in weight of tomatoes, after harvest, may be considerable depending upon the weather, the condition of the fruit, and the duration of storage. Loss of weight is, however, less in No. 1 than in No. 2 tomatoes.

Some workers are unable to distinguish properly between red and green. This condition, known as colour blindness, is definitely a handicap and those who are so afflicted should not engage in tomato picking.

CARE IN HANDLING

The care with which tomatoes are handled, both before and after they are placed in shipping containers, is an important factor in establishing the grade. The picking of tomatoes directly into shipping containers results in less bruising than where fruit is picked into pails or baskets and dumped into crates for delivery to the factory.

The hauling of tomatoes to the receiving station or factory is sometimes done by truckers on a per-container basis. Under such circumstances, and when growers are short of containers, there is a temptation to heap tomato crates and hampers. Such action is false economy owing to wastage through spillage and to the lowered grade accorded crushed, damaged, and rotted fruit.

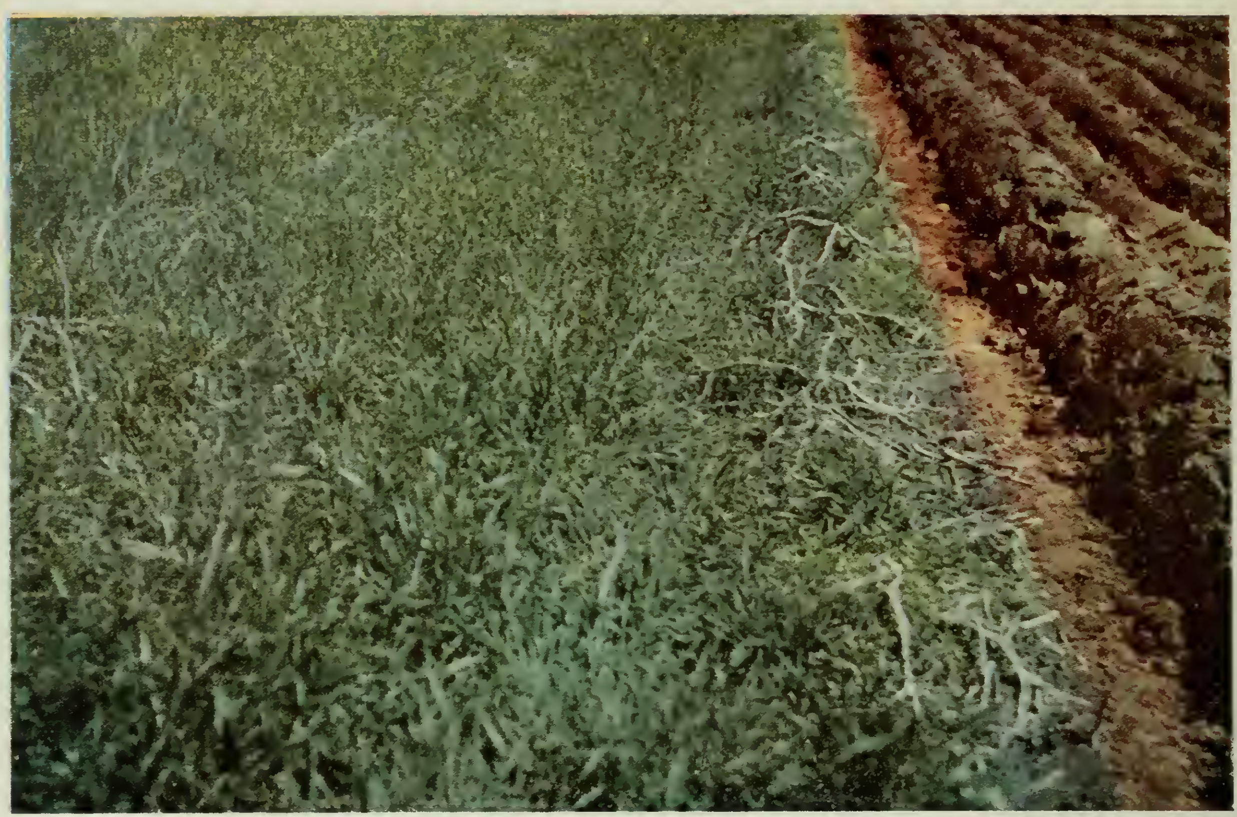


FIG. 12. On the lighter soils, rye grass, sown in tomato crops at the time of the last cultivation, will protect the soil over winter, utilize and hold available soil nutrients, and contribute organic matter. Note that, at the time of spring plowing, tomato vines and skins are almost hidden by lush growth.

FREQUENCY OF PICKING

The frequency with which a tomato crop is harvested will be influenced by several factors. Thoroughness in picking, however, is recognized as a more important consideration than frequency of picking if growers are to obtain the highest grades and therefore the maximum returns from crops produced.

The frequency of picking will be influenced by the weather, pickings being more frequent during warm, wet weather. An impending frost also may justify an effort to harvest fruit as No. 2 grade rather than risk its not maturing to No. 1 grade. Well-grown crops of high-quality fruit will require less-frequent picking than will poorer crops. MacGillivray,* discussing frequency of picking under Indiana conditions states,

> "There is a relationship between the percentage of U.S. No. 1's and the length of time they will remain No. 1's. In a field harvesting 5 per cent U.S. No. 1's, the fruit will remain as 1's for about 2.5 days, while a field with 95 per cent U.S. No. 1's will remain as 1's for about 8.5 days and proportional times between. A farmer can be guided by grade obtained as to the frequency of picking. The highest percentage grade was obtained in the first two-thirds or three-fourths of the season. There was little difference in soil types when well supplied with organic matter, but sand low in organic matter produced a low percentage of U.S. No. 1's."

---

* Profits in Tomato Picking; Indiana Agricultural Experiment Station, Leaflet No. 181, 1936.

CONTAINERS

While the 60-pound or bushel crate continues to be the most popular container in Eastern Ontario it is gradually giving way to the 30-pound or half-bushel crate, and to the ⅝-bushel hamper. Growers and processors in this area seem to prefer the crate since it lends itself to loading on wagons and nests more closely on small factory platforms.

The advantage of the hamper lies in the fact that it constitutes the picking container, and fruit is not bruised when dumped from pail or basket. By virtue of their shape the sloping sides of hampers assist to support the weight of fruit, thereby reducing crushing. Another advantage of the hamper is that air can circulate between stacked containers thereby reducing the development of mould.

The large 60-pound crate, which more frequently carries 65 to 70 pounds of fruit, should not be used for tomatoes. This container has been aptly and correctly called "a quality-killer and a man-killer". If tomatoes are harvested at the correct stage of maturity to get a high grade those in the bottom of the bushel crate will invariably be crushed.

UNITS OF MEASUREMENT

Two distinct units are employed for measuring yield of processing tomatoes in Ontario. In Central and Western Ontario where ⅝-bushel hampers are in general use the accepted basis for production and sale is tons per acre. In Eastern Ontario where the 60-pound or bushel crate is still in general use, production and thinking is still in terms of bushels per acre. For practical purposes 33 bushels of tomatoes equal one ton. A 10-ton crop would be 330 bushels. Ontario's 10-year average of 6 tons per acre is 200 bushels only.

GRADES FOR TOMATOES FOR CANNING

Under Regulations 87 of Consolidated Regulations of Ontario, 1950, as amended by O. Reg. 138/51, the grades for tomatoes for canning are:

TOMATOES
(Canning)

122.—(1) The grades for tomatoes where purchased from the grower on a grade basis for canning purposes shall be,

(*a*) **No. 1 Grade.**—This grade shall consist of tomatoes which are firm, ripe, well-formed, well-coloured, and free from moulds and decay and from damage caused by growth cracks, worm holes, cat-faces, sun scald, freezing injury or mechanical or other means.

(*b*) **No. 2 Grade.**—This grade shall consist of tomatoes which do not meet the requirements for No. 1 grade but are ripe, fairly well-coloured and free from serious damage.

(*c*) **No. 3 Grade.**—This grade shall consist of tomatoes which do not meet the requirements for No. 2 grade.

(2) The minimum size for each grade may be fixed by agreement between the seller and purchaser and tomatoes below the fixed minimum shall be culls.

(3) In subregulation 1,

(*a*) "damage" means any injury which causes a loss to a tomato in trimming and peeling of more than 10 per cent by weight;

(*b*) "fairly well-coloured" means that the tomato shows at least two-thirds red colour;

(*c*) "firm" means that the tomato is not soft, puffy, shrivelled or water-soaked;

(*d*) "serious damage" means any injury which causes loss to a tomato in trimming and peeling of more than 20 per cent by weight;

(*e*) "well-coloured" means that the tomato shows at least 90 per cent of red colour; and

(*f*) "well-formed" means that the tomato is fairly round and not badly misshapen.

123.—(1) The grades for tomatoes where purchased from the grower on a grade basis for the manufacture of strained tomato products shall be,

(*a*) **No. 1 Grade.**—This grade shall consist of tomatoes which are fairly firm, ripe, well-coloured and free from stems and frost injury and damage caused by discoloured cracks, shrivelling, moulds, decay, insects, sunburn, sun scald, woody cat-faces, or other means.

(*b*) **No. 2 Grade.**—This grade shall consist of tomatoes which are ripe, fairly well-coloured and free from serious damage.

(*c*) **No. 3 Grade.**—This grade shall consist of tomatoes which do not meet the requirements of No. 2 grade.

(2) In subregulation 1,

(*a*) "damage" means an injury which affects the quality of the tomato for puree purposes and shall include sunburn, insect injury, sun scald, woody cat-faces and shrivelling which cannot be removed in the ordinary process of trimming without a loss of more than 10 per cent by weight of the tomato;

(*b*) "fairly firm" means that the tomato is not water-soaked, puffy or sun-blistered;

(*c*) "fairly well-coloured" means that at least two-thirds of the flesh of the tomato has red colour;

(*d*) "serious damage" means an injury which seriously affects the quality of the tomato for puree purposes and shall include decay which has caused the tomato to become sour, spots, blossom-end rot, soil rot, sunburns, sun scalds and any other decay or disease which cannot be removed without a loss of more than 20 per cent by weight of the tomato; and

(*e*) "well-coloured" means that at least 90 per cent of the flesh of the tomato has red colour.

124. Tomatoes grown and sold for processing shall be bought by a processor on a grade basis but this regulation shall not apply where a processor buys or agrees to buy for processing in any year fewer than 8000 bushels or 240 tons of tomatoes or the tomatoes grown on fewer than 30 acres.

When graded, tomatoes for canning are purchased only on the basis of No. 1 and No. 2 Grades. Tomatoes which are below the requirements set for No. 2 Grade are considered as culls.

BASIS OF SALE

Tomatoes for processing are produced and marketed in Ontario subject to the regulations passed by the Ontario Vegetable Growers' Marketing-for-processing Scheme, administered by the Farm Products Marketing Board.

In order that the marketing of the crop may be orderly, the Board requires that every grower of tomatoes for processing shall have a written contract with a processor for the purchase of his crop. Processors in turn must obtain a license from the Farm Products Marketing Board before they may purchase tomatoes for processing. Except as provided for under regulation 124 of the Farm Products Grades and Sales Act, (see above) all processors must contract for and purchase tomatoes upon the basis of established grades determined by authorized graders of the Ontario Department of Agriculture. Grade standards for canning tomatoes are defined in regulations made under the Farm Products Grades and Sales Act. Official grading stations, as required under the regulations, are located at the major receiving stations and processing plants.

Each year prior to contracting, authorized representatives of growers and processors meet to negotiate minimum contract prices and conditions of sale. In the event growers and processors comprising the negotiating committee fail to agree, contract prices are arbitrated, the arbitrators consisting of a chairman who is usually a county judge, and two representatives, one appointed by the growers and one by the processors.

Following negotiations and/or arbitration, the Farm Products Marketing Board each year issues what is known as a marketing agreement. This agreement stipulates the minimum prices which shall be paid for the current year's crop and lists those conditions of sale which have been agreed upon or awarded on the basis of arbitration. Provisions of the marketing agreement always take precedence over any contrary conditions which may exist in contracts signed between grower and processor.

CONCLUSION

Tomatoes are an important cash crop in Ontario. The low average-yield per acre, however, indicates that many crops do not represent farm enterprises which are profitable.

This bulletin endeavours to focus attention upon those factors which contribute to success in tomato production. By so doing it aims to assist growers to increase the yield per acre of high-quality fruit. This in turn will reduce the number of unprofitable enterprises which serve only to further degrade the soils upon which they are produced.

The pressing need is for *better* acres, not *more* acres of processing tomatoes.

ACKNOWLEDGMENTS

The manuscript was reviewed in whole or in part by research personnel representing several Departments at the Ontario Agricultural College; the Division of Horticulture, Central Experimental Farm; and the processing industry. The co-operation of these workers is greatly appreciated. We wish to acknowledge illustrations as follows: Department of Botany, Ontario Agricultural College, Figs. 9, (b), (e), and (f). The processing industry, the front cover, and Figs. 3, 4, 6, 7, 8 and 10.

BULLETIN No. 492
SEPTEMBER, 1952

ONTARIO SOILS their USE, MANAGEMENT and IMPROVEMENT

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

This bulletin was written for the farmer and others interested in the Use, Management and Improvement of Ontario soils. Many farmers are already using sound soil management practices which are basic to good land use and soil conservation. Some of our soils are now in a high state of productivity. Others, because of exhaustive cropping practices, damage from erosion, or inherently low content of plant food have been depleted of fertility.

The many factors influencing fertility depletion and erosion are discussed in the bulletin. Practices that will reduce erosion and assist in maintaining a highly productive soil are recommended. Most unproductive soils can be made useful by intelligent management. The suggested land use practices herein contained are made to assist farmers and farmers-to-be to devise means and ways of using land according to its capability, to culture and manage each acre according to its needs and to sustain its maximum productivity.

Whether we own land or not, we are dependent upon the products of the soil for the necessities of life. Each of us has a vital concern in the use, management and improvement of our soil resources to maintain or increase productivity.

All photographs used in this bulletin were taken on farms in Ontario.

ONTARIO SOILS—
their USE
MANAGEMENT
and IMPROVEMENT

by

L. R. Webber, F. F. Morwick, T. J. Heeg,
N. J. Thomas and N. R. Richards

ONTARIO AGRICULTURAL COLLEGE
DEPARTMENT OF SOILS

ONTARIO DEPARTMENT OF AGRICULTURE
Statistics and Publications Branch, Toronto, Ontario.

BULLETIN 492 **MAY 1952.**

CONTENTS

Page

INTRODUCTION - - - - - - - 1

FACTORS INFLUENCING SOIL PROBLEMS - 2

SOIL FERTILITY

- Organic Matter - - - - - - 4
- Farm Manures - - - - - - 8
- Green Manures - - - - - - 14
- Nutrient Supply - - - - - - 14
- Soil Reaction - - - - - - 15
- Nitrogen - - - - - - - 16
- Phosphorus - - - - - - - 17
- Potash - - - - - - - - 18

LAND DRAINAGE - - - - - - 18

SOIL EROSION AND METHODS OF CONTROL

- Types of Erosion - - - - - - 19
- Factors Affecting Erosion - - - - 21
- Principles of Erosion Control - - - - 25
- Tillage - - - - - - - - 28
- Contour Cultivation - - - - - 30
- Strip Cropping - - - - - - 30
- Mulching - - - - - - - 33
- Wind Erosion - - - - - - - 33

SURPLUS WATER

- Grass Waterways - - - - - - 34
- Diversion Ditches - - - - - - 36
- Terraces - - - - - - - 37
- Gully Control - - - - - - - 38

FARM PONDS - - - - - - - 40

WOODLOTS and REFORESTATION - - - 41

EDUCATION RESEARCH and EXTENSION - 42

TITLES OF REFERENCE READING - - - 44

ONTARIO SOILS

their

USE, MANAGEMENT and IMPROVEMENT

Down through the ages an adequate supply of food has been one of man's important problems. There has been a constant struggle to provide enough food for all people. In many nations man's very existence has been, and still is, blighted by the lack of food.

Many authorities agree that soil deterioration is preceded by a deterioration of man's ability to understand and manage a soil according to its capability. Archaeological investigations in foreign lands have revealed ancient cities that once stood in the midst of flourishing agricultural regions. These findings support the assumption that soil erosion and soil exhaustion forced the people to abandon the land. With the primitive modes of transportation, these great cities could not exist far from a supply of food. They were surrounded by fertile fields; today many of these are deserts.

Abandoned Farm Buildings.
This land once grew mighty beech and maples. Early settlers selected land, the productivity of which was indicated by a shovel or by the growth of trees. Excellent tree growth was not a true value of this land for farming.

When man first cultivated the soil, he upset the balance that Nature had established between the soil and the vegetative cover. It is fully realized that the balance must be disturbed in order that man may eat. He is not content to live as an animal. As a custodian of a great natural resource, the soil, man has not always been a faithful steward. On many occasions and in many places he has exploited the soil.

In Ontario we are fortunate in having a supply of food that has generally been adequate for a relatively high standard of living. We have no deserts nor mass abandonment of land through previous exploitation of the soil, but we do have soil depletion problems. Erosion has become serious in parts of the Province.

FACTORS INFLUENCING OUR SOIL PROBLEMS

Many factors have contributed to our current soil problems. This is not the place to discuss such topics as: man's desire to get rich quick; the economic effect of prices, wages or subsidies; the impact on Ontario agriculture of war, peace and exports; the contributions and obligations of industry; the security of sharecroppers or of those who rent farms and those who farm on a part-time basis.

Factors such as climate and soil variation have an effect on soil depletion and soil erosion. These factors often determine the type of farming peculiar to areas of Ontario, which in turn affect our soil problems. Ontario soils vary widely in topography, natural reserves of plant food, soil reaction, organic matter, texture and drainage. Some soils are deep, rich, naturally well drained; others are shallow with rock outcrops; others are smooth undulating clays, and others sands and gravel.

It is over a thousand miles from the extreme southern point to the northern limits of the Province. From north to south there are extremes in climate. Parts of Northern Ontario may expect frost any month of the year while in the southern part the frost-free period averages 167 days. The annual precipitation, rain plus snow, in Ontario ranges from 25 to 40 inches. The soils in most of the southern counties are frozen for several months of the year.

In addition to soil variations and climatic differences, we have in Ontario over 22 million acres of farm land subdivided into 178,000 occupied farms. Many and varied are the land use problems and the ways of managing a soil when there are so many individual farmers.

No overall planning of the settlement and utilization of soils prevailed at the time of clearing and establishment. The pioneer's chief desire was freedom, independence and security in exchange for hard work, hardship, and for some, adventure. The settlers were largely self-sufficient and built around themselves self-supporting communities. Many and varied were the reasons why people settled in different parts of this Province. From past experience many were soil conscious and selected land whose productivity was indicated by a shovel or by tree growth. Others opened tracts of land where they could maintain family or racial clannishness and gave little thought to the quality of the soil.

In Ontario, farms were usually surveyed into square or rectangular hundred-acre lots. A lane was established through the middle of the farm, and fields, square or rectangular, were fenced on either side of the lane. Regardless of topography or soil type, tillage and cropping operations were generally conducted parallel with a road, lane or fence. Tradition has contributed to practices that are hard to change and has hampered the introduction of improved land use practices.

While many factors have contributed to our problems in the use and management of soils, investigational work already conducted in Ontario indicates that our problems may be associated with one or a combination of fertility, drainage and erosion.

A prosperous Ontario farm.

This farm is one of many in Ontario where soil depletion is not evident. Level and gently rolling land remain productive when the farm operator practises good soil management.

The ability of a soil to provide plant nutrients for crop growth is closely related to soil texture. A sandy soil is characteristically low in organic matter and clay. These are necessary in the storage of water and plant nutrients. Water moves readily through sandy soils and by a process of leaching depletes the soil of nutrients. Clay soils retain more plant nutrients and are subject to less leaching than the lighter textured soils (sands and sandy loams).

Inadequate drainage interferes with the growing of those crops that require good drainage. Indeed, unsatisfactory drainage may preclude the possibility of including such crops as alfalfa and red clover in a crop rotation, thereby greatly reducing the nutritive value of the forage produced. There are large and extensive areas in Ontario where inadequate drainage is the number one land use problem. Usually mechanical means of some form are necessary to remove the excess water. Once a soil has been drained the improved aeration encourages a more rapid depletion of the organic matter. Maintaining adequate fertility levels is often a greater problem in artificially drained soils than in soils with good natural drainage. Soils are drained to increase the number of crops that can be successfully grown and to create a more satisfactory moisture environment for those already growing.

The physical character of the land is the most significant aspect in determining the susceptibility of soil to erosion. There is a tendency for people to be much slower in becoming conscious of the menacing effects of erosion than in recognizing either fertility or drainage needs. This is due, in no small part, to the slow insidious manner with which erosion depletes our soil resources. Because of the type of topography common to a large part of Ontario, millions of acres are susceptible to sheet erosion. The degree to which soils have suffered from erosion depends on soil texture, length and per cent slope, and the cropping practices. Large areas of sandy soils have suffered from or are susceptible to wind erosion. Often subsoil and parent materials become exposed through prolonged wind or water erosion.

SOIL FERTILITY

Soil fertility is the ability of a soil to supply plant nutrients. In the soil will be found organic matter, plant nutrients, air and water. As these nutrients increase in available amounts and maintain an optimum ratio among themselves, the fertility of the soil is said to be improved.

A highly fertile soil may not be a productive soil if one or more factors are not favourable to crop growth. Soil productivity is a very broad term encompassing fertility, physical condition, drainage, climatic and seasonal conditions, and cultural practices.

This bulletin mentions but a few factors involved in the management of soils to keep them productive. It is widely recognized that soil fertility maintenance is perhaps the dominant conservation problem associated with Ontario soils.

SOIL ORGANIC MATTER

Soil organic matter refers to the remains of all plant and animal life in various stages of decomposition in the soil. Humus is a product from the decomposition of fresh organic matter. Fresh organic matter is subject to relatively rapid decomposition under favourable conditions. Humus, on the other hand, is comparatively stable, but is nevertheless also subject to destruction. Because the term organic matter covers all forms of organic material, it will be used here almost entirely.

The Functions of Organic Matter

Organic matter is made up chiefly of the elements carbon, hydrogen, oxygen and nitrogen. There is no mineral which supplies nitrogen naturally to soils. Practically all nitrogen in the soil is in, or was supplied by, the organic matter, with the exception of that which might have been supplied by manure, fertilizers, rain and snow.

Organic matter in adequate amounts:

- **promotes the formation of granules**
- **assists the infiltration of rainfall**
- **encourages deeper rooting**
- **increases resistance to erosion**
- **imparts good soil aeration**

A feature of good structure in heavier soils is the presence of granules. Heavy soils, on drying, frequently become excessively hard and form wide deep cracks, because clay shrinks considerably as it dries. When a clay soil is well supplied with organic matter, each clay particle is lightly smeared with it, thus reducing the baking action and the cracking.

On sandy soils organic matter improves the infiltration of rainfall and the water-holding capacity, enabling them to supply moisture to plants over a longer period of dry weather.

Organic matter is the chief source of food and energy for a great variety of organisms. One of the products of this breakdown of organic matter is the gas carbon dioxide, a part of which is dissolved in the soil moisture to form a weak acid. This weak acid plays an important role in slowly releasing nutrients from the mineral matter.

Of the larger organisms, earthworms are probably the most important. They pass large amounts of soil through their bodies, digesting the organic matter and leaving it in a state favourable for easy decomposition by the micro-organisms. Their burrowing leaves channels in the soil for air and water penetration. The number is small in soils low in organic matter, but the population of earthworms increases when fresh organic material is added.

DEPLETION OF ORGANIC MATTER

The decomposition of organic matter in a soil may be compared to burning coal in a furnace. If three-inch lumps of coal are placed on a fire they tend to burn more quickly than lumps of a half-inch size. When very small coal particles are used, forced air from a blower is almost necessary to induce combustion. The larger lumps of coal have larger air spaces between them than the smaller pieces, allowing combustion to take place more rapidly.

Particles making up a sandy soil are large in size with consequent big pore spaces between them. Clay soil particles are very small in size, and it follows that their pore spaces are small. Well drained sandy soils are lower in organic matter than clay soils of similar good drainage, because there is more air present for rapid decomposition. Fresh organic material added to a sandy soil soon decomposes, reaching a low organic matter equilibrium. The same fresh organic material applied to a clay soil will also decompose until the balance for this soil is reached, but the decomposition rate will be slower. In general it is not economically possible to maintain as much organic matter in a sandy soil as in a clay.

Any tillage operation incorporates air into a soil. When the drafts of a furnace are opened, more air is supplied to the burning coal, increasing combustion. Cultivation increases the draft or air supply in the soil, causing more rapid decomposition of organic matter. While cultivation hastens destruction of organic matter, it nevertheless is essential. If plants are to grow, air must be supplied to the roots. Certain crops, for example the grasses and legumes, require no further cultivation than the preparation of a seed bed. Others, like corn, potatoes and vegetables, usually receive one or more cultivations during their growth period. In the destruction of organic matter through cultivation, microbiological activity is increased, and valuable nutrients are released. Cultivation speeds up the tempo in the soil factory to produce more available nutrients and thereby to increase yields. Some cultivation is required if crops are to be grown successfully, but because organic matter destruction is hastened, it should be kept at the minimum necessary for optimum yields.

EFFECT OF CROPPING ON ORGANIC MATTER LOSSES

The amount and the kind of residue which a crop leaves in a soil are all important. Good soil humus has an approximate ratio of twelve parts of

Crop residues to be turned under.

If straw, corn stalks or other non-leguminous crop residues are turned under, a nitrogenous fertilizer should be broadcast on top of the hay or straw before discing or plowing.

carbon to one part of nitrogen. The closer the fresh organic material is to this ratio, the more chance there will be for its accumulation in the soil as humus. If grain straw is turned under, the carbon addition is large but the nitrogen content is low. The ultimate effect in all probability is nitrogen starvation in the following crop, and little increase in organic matter. The straw stubble and roots contain a large amount of carbon with little nitrogen. The micro-organisms have a large supply of energy at their disposal, in the form of carbon. If they are to grow and multiply, they must have nitrogen to form the protein of their bodies. The rate of decomposition of the straw will be dependent upon the amount of nitrogen the soil humus can supply. Thus all of the nitrogen released by the soil humus is used by the micro-organisms to build their body tissue with little left for the crop. Plowing down straw and other carbonaceous residues causes a shortage of available nitrogen for the succeeding crop which may last over the whole season. To overcome this situation, a nitrogen fertilizer should be applied at the time of plowing under the residue to give the equivalent rate of 75 pounds of ammonium nitrate per ton of residue. This supplies the nitrogen for the micro-organisms, instead of depending on that released from the soil humus. In this way more residual humus may result, and the succeeding crop will be less likely to show a nitrogen deficiency.

Poorly handled manure or manure with excess straw may cause nitrogen starvation when applied to a field. What has been said for straw is also true of corn stalks and old grass sods in which there are few legumes.

Legumes when properly inoculated need little soil nitrogen. They fix nitrogen from the air in excess of their needs. If the soil itself has a high nitrogen content, the bacteria on roots of legumes will use it instead of

AVERAGE DAILY AMOUNT AND COMPOSITION OF SOLID AND LIQUID EXCREMENT OF MATURE ANIMALS

Kind of Animal	Daily Production per Animal		Composition of Fresh Excrement							
			Dry Matter		Nitrogen		Phosphate (P_20_5)		Potash (K_20)	
	Solid	Liquid	Solid	Liquid	Solid	Liquid	Solid	Liquid	Solid	Liquid
	Pounds	Pounds	%	%	%	%	%	%	%	%
HORSES	35.5	8.0	24.3	9.9	0.50	1.20	0.30	Trace	0.24	1.50
CATTLE	52.0	20.0	16.2	6.2	0.32	0.95	0.21	0.03	0.16	0.95
SHEEP	2.5	1.5	34.5	12.8	0.65	1.68	0.46	0.03	0.23	2.10
HOGS	6.0	3.5	18.0	3.3	0.60	0.30	0.46	0.12	0.44	1.00
HENS	0.1	......	35.0	......	1.00	......	0.80	......	0.40	......

Table from Salter and Schollenberger: Yearbook of Agriculture, 1938.

fixing nitrogen from the air. However, a little nitrogen fertilizer at seeding time often assists the young plants to establish themselves, without interfering with nitrogen fixation.

ORGANIC MATTER

- **natural source of nitrogen**
- **storehouse for essential nutrients**
- **makes fertilizer and lime more effective**
- **improves the physical condition**
- **reduces erosion losses**

FARM MANURES

Value of Farm Manure

Manure contains valuable nutrient elements necessary for the growth of plants. On a percentage basis, manure has an average composition of 0.5 per cent total nitrogen, 0.25 per cent phosphoric acid ($P_2 0_5$), and 0.5 per cent potash (K_2O). A five-ton application of manure per acre would be approximately equivalent to a fertilizer application of about 500 pounds of 10-5-10.

Every farmer knows the beneficial results accruing from the use of manure. It supplies a large amount of organic matter in a form easily decomposed by micro-organisms. This increases microbial action. It improves the physical condition of a soil, tending to knit the loose sand particles together and opening up heavy clay soils. It improves the water-holding capacity of sandy soils and assists in the infiltration of rainfall in both light and heavy soils. Fields top-dressed with manure are afforded protection from beating rains.

Losses in the Handling of Manure

Manure is an ideal food for micro-organisms; they commence to decompose it immediately. Decomposition of the manure is desirable in the soil but when manure decomposes in the pile, nitrogen is lost to the air and the soluble minerals are leached out by rain.

The first losses may occur in the stable if insufficient bedding is used to hold the moisture, because 40-75 per cent of the fertilizing value of manure is in the liquid portion.

Manure spread on the surface of the soil will lose as much as one-third of the total nitrogen within a week at ordinary summer temperatures.

When manure is placed in shallow piles, and not compacted, conditions are perfect for heavy losses. Heating in the pile assists in the loss of ammonia. Forking over a pile of manure is not advisable because it allows air to enter, and further assists in decomposition.

Rainfall tends to leach manure. When it is considered that a one-inch rainfall is equivalent to about two quarts of water per square foot, it is not difficult to visualize the amount of loss which can take place in this manner.

Proper Handling of Manure

It is almost impossible to entirely avoid losses in manure handling; perhaps the nearest approach to complete avoidance of loss is to haul

Spreading manure on pasture.

Pastures and new seedings give excellent response to light or moderate applications of manure. It is important to spread manure evenly and avoid smothering the small plants.

Loosely piled manure is leached by rain.

When manure cannot be spread and must be stored outside, it should be packed tightly in large, straight-sided piles.

Spreading manure on snow.

Winter spreading of manure should be confined to nearly level land. Some losses will occur but the practice allows a more efficient use of farm labour.

manure daily to the field and to plow it in immediately. This is not always possible, but the closer the approach to this practice the better will be the returns.

LOSSES OF FERTILIZING CONSTITUENTS IN THE ROTTING OF MANURE

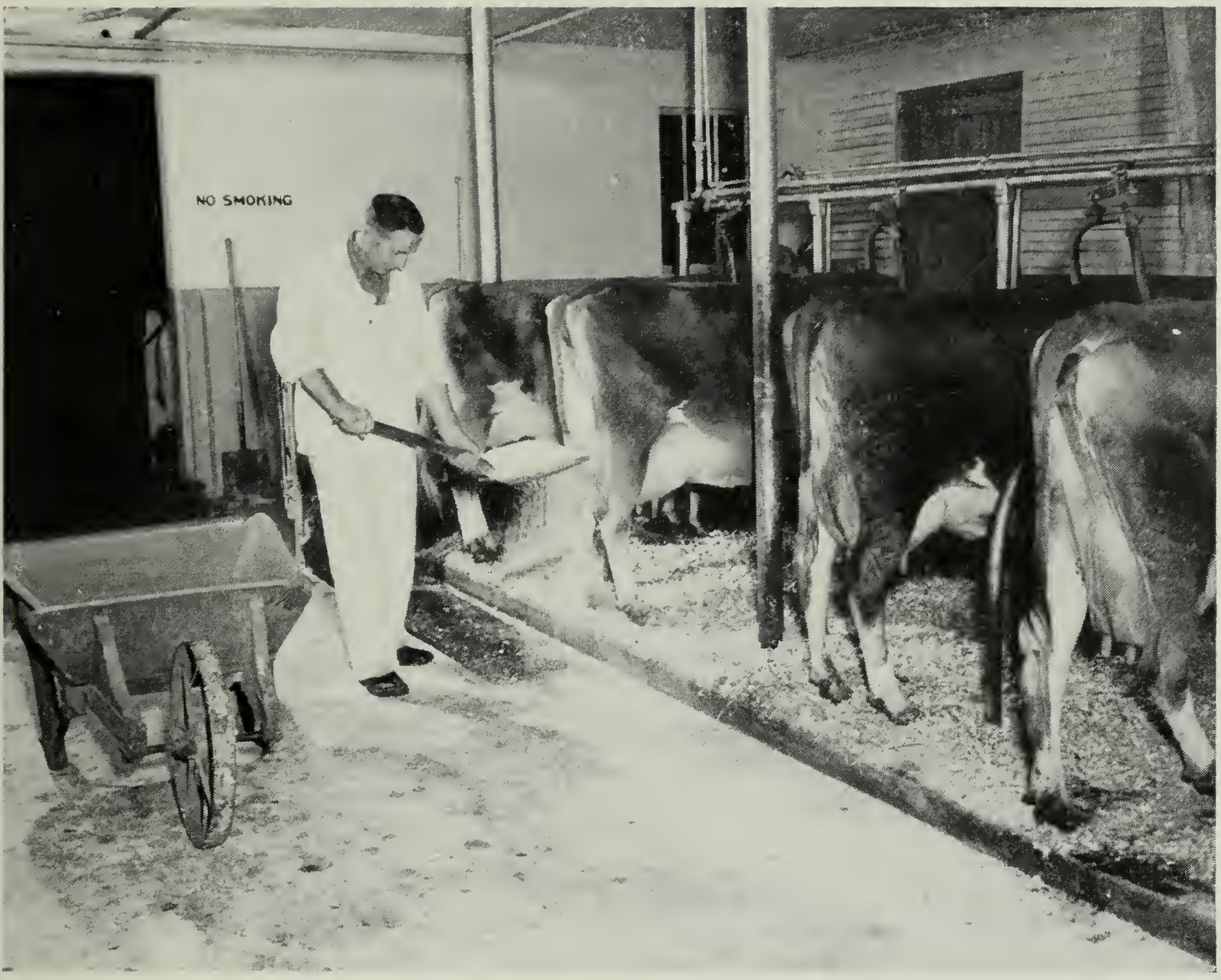
Central Experimental Farm, Ottawa.

	Rotted for 6 months		Rotted for 12 months	
	Protected	Exposed	Protected	Exposed
	%	%	%	%
Organic Matter	58	65	60	69
Nitrogen	19	30	23	40
Phosphoric Acid	None	12	4	16
Potash	3	29	3	36

This experiment indicated that fresh manure when rotted for six months lost one-half to two-thirds of its original weight.

If manure is to be stored, it should be stacked in a pile of small base and tightly packed. Covered manure pits are a recommended means of storage.

Manure should not be spread on frozen or snow-covered rolling land. In such cases most of the soluble matter may be leached out by snow or rain to be lost in the runoff.



Spreading phosphate in the stable gutter.

Ontario soils and manure are generally low in phosphate. Adding phosphate in the stable absorbs the liquid and increases the fertilizing value of manure.

PRESERVING MANURE WITH CHEMICALS

There are two reasons why preservatives have been proposed:

1. to reduce odour,
2. to prevent the loss of ammonia.

The most widely used preservative is superphosphate. Ammonia in the manure combines with the superphosphate so that it cannot escape as gas. The ammonia, however, is still susceptible to loss by leaching. Soils treated with phosphated manure frequently show a high phosphorus test. The present recommendation advocates the use of 50 pounds of superphosphate per ton of manure, applied to the gutters in the stable. This is equivalent to 2-2½ pounds for each mature animal per day.

Gypsum and limestone are of little use in preserving the nitrogen in manure. Burned lime and slaked lime assist in the loss of ammonia.

WHERE TO APPLY MANURE

Manure should be applied for any crops having a high nitrogen requirement. Corn responds well to manure applications of 5-10 tons per acre. Potato yields are also increased with the use of manure. Vegetable crops and small fruits in general respond to manure. Manure has proved beneficial when applied at seeding time or as a top dressing on established pastures.

If manure contains an excess of straw, it may induce nitrogen deficiency in the crop. In such cases, apply about 50 pounds of ammonium nitrate or a corresponding amount of any other available nitrogen fertilizer per acre to correct this situation.

Manure may be applied for any crop, but rates of application should not be as high for small grains as for corn or other crops requiring more nitrogen. Poor land will respond better than rich land. Knolls should be treated more heavily than other parts of the field.

RELATIVE VALUES OF FRESH AND ROTTED MANURES

It was pointed out above that in rotting manure, the fermentation processes release ammonia, containing nitrogen, as a gas. The loss of this gas represents a loss of valuable nitrogen. A better balance of nitrogen, phosphate and potash is attained in rotted manure, which usually means better plant growth. Weight for weight rotted manure contains larger percentages of plant food in a more available form than fresh manure. However, under the conditions of rotting there is a loss in fertilizing constituents, especially nitrogen and organic matter.

COMPOSITION OF FRESH AND ROTTED (SIX MONTHS) MANURES

Central Experimental Farm, Ottawa.

	Nitrogen %	Phosphoric Acid %	Potash %
Fresh	0.60	0.31	0.78
Rotted and protected	1.69	1.08	2.60
Rotted and exposed	0.80	0.53	1.07

The manure referred to above was equal parts of horse and cow manure. This data appeared in more detail in Farmers' Bulletin No. 40 issued by the Central Experimental Farm, Ottawa.

The above bulletin proceeded to make general recommendations regarding the use of fresh and rotted manures:

"Fresh manure is better suited to clays and heavy loams than to light soils since its coarseness does much to improve their physical condition by opening them to the air and making them more friable. On the other hand, rotted manure is better suited to light sandy soils, tending to make them more compact and retentive of moisture.

"Fresh manure may with advantage be used for crops which have a long season of growth, while rotted manure, with its more available plant food, gives better results for such crops as gather their food and reach maturity during a short period, and where early marketing is an important consideration."

MANURE

- **low in phosphates**
- **high fertilizing value in the liquid portion**
- **must be well packed in storage**
- **improve crop production**

Sweet clover as a green manure crop.
Sweet clover and other legumes accumulate nitrogen in their roots. Additional nitrogen may be needed for certain crops with high nitrogen requirements, such as corn.

Plowing under a stand of grass.
Green manuring adds organic matter in a readily decomposable form provided enough nitrogen fertilizer is added to encourage the rotting process and to offset the possibility of nitrogen deficiency in the succeeding crop.

GREEN MANURES

Green manuring is a recommended practice. Yet it has perhaps not increased organic matter levels greatly. This may be due to the fact that a green manure crop is usually followed by a row crop. Green manuring does supply organic material, and when turned under causes a great increase in the desirable microbiological activity.

Legumes are greatly superior to non-legumes as green manures, but it may not be feasible to use the slower growing legumes. Second growths or hay aftermaths are often plowed under when not required for supplemental pasture. Fall-sown rye is a common green manure crop preceding row crops like corn, tobacco and potatoes. With rye as a cover or green manure crop 10-14 days are required in the spring for partial decomposition prior to planting the succeeding crop. It is desirable to incorporate the rye with the soil before it reaches a height of 12-15 inches. This delay in planting after rye rarely permits the planting of spring grains like barley or oats. For land or conditions where a winter cover crop is desired, but no spring growth, oats may be used. The fall growth of oats protects the soil from washing, adds organic matter, but no spring growth occurs to delay planting.

FACTORS AFFECTING NUTRIENT SUPPLY

A plant is a "factory" manufacturing carbohydrates, proteins, fats and oils, using the carbon dioxide from the air, water and nutrient elements from the soil, and sunlight. Soil contains the nutrient elements nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, boron, zinc, copper and molybdenum. The major elements are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. The minor elements are those required in minute amounts—iron, manganese, boron, zinc, copper and molybdenum.

Each crop has a different requirement in amount and proportion of the nutrient elements, and soils vary in their capacities to supply them. A soil test is a practical means at a grower's disposal to ascertain the amounts of these available nutrients in his soils.

THE AVAILABILITY OF NUTRIENTS IN THE SOIL

Nutrients exist in the soil in three distinct forms:

1. difficultly available,
2. moderately available,
3. readily available.

The difficultly available forms are within the soil mineral and that part of the organic matter referred to as humus. The minerals and humus are the insoluble stock piles from which available nutrients are slowly released by the forces of weathering and organisms.

The moderately available nutrients are those contained in fresh organic matter and those held in mineral forms which can be reasonably easily dissolved.

The readily available nutrient supply exists in forms easily dissolved for plant root absorption.

In depleted or rundown soils, the amounts of readily and moderately available forms are low, causing restricted growth. Fertile soils supply a crop with sufficient amounts of readily available nutrients for high yields.

After harvest, the depleted supply of the readily available forms may be regenerated from the less available forms and from the use of manure, lime and fertilizer.

THE SOIL WAREHOUSE

In a soil, the warehouse is the clay and organic matter. The available nutrient elements, calcium, magnesium, potassium, iron, manganese, zinc and copper, are stored here, so that the plant root may easily procure them.

Phosphorus and boron are held in a soil by a different system. Nitrogen is held against leaching in the organic matter, but once this nitrogen is released by soil organisms as nitrate, it is not stored by any system and could be leached out of the soil. The more clay and organic matter in a soil, the greater is its capacity to absorb water and store certain nutrients against leaching. A sandy soil has a small warehouse.

SOIL REACTION

Soil reaction refers to the degree of acidity or alkalinity of a soil. It affects crop growth both directly and indirectly. All plants have a preferred range in soil reaction in which they grow best.

FAVOURABLE pH RANGES FOR SOME CROPS

FIELD CROPS	
Alfalfa	6.2-7.8
Barley	6.5-7.8
Clover	6.0-7.5
Field Beans	6.0-7.5
Field Peas	6.0-7.5
Oats	5.0-7.5
Rye	5.0-7.0
Soybeans	6.0-7.0
Wheat	5.5-7.5

HOED CROPS	
Beans	6.0-7.5
Corn	6.0-7.5
Mangels	6.0-7.0
Potatoes	4.8-6.5
Pumpkin	5.5-7.5
Sugar Beets	6.5-8.0
Tobacco	5.5-7.5
Tomatoes	5.5-7.5
Turnips	5.5-6.8

FRUIT CROPS	
Apple	5.0-6.5
Blueberry	4.0-5.0
Cherry	6.0-7.0
Grape	5.5-7.0
Peach	6.0-7.5
Pear	6.0-7.5
Plum	6.0-8.0
Raspberry	5.0-7.0
Strawberry	5.0-6.5

VEGETABLE CROPS	
Cabbage	6.0-7.5
Carrots	5.5-7.0
Cauliflower	5.5-7.5
Celery	5.8-7.0
Cucumbers	5.5-7.0
Lettuce	6.0-7.0
Onions	5.8-7.0
Peas	6.0-7.5
Table Beets	6.0-7.5

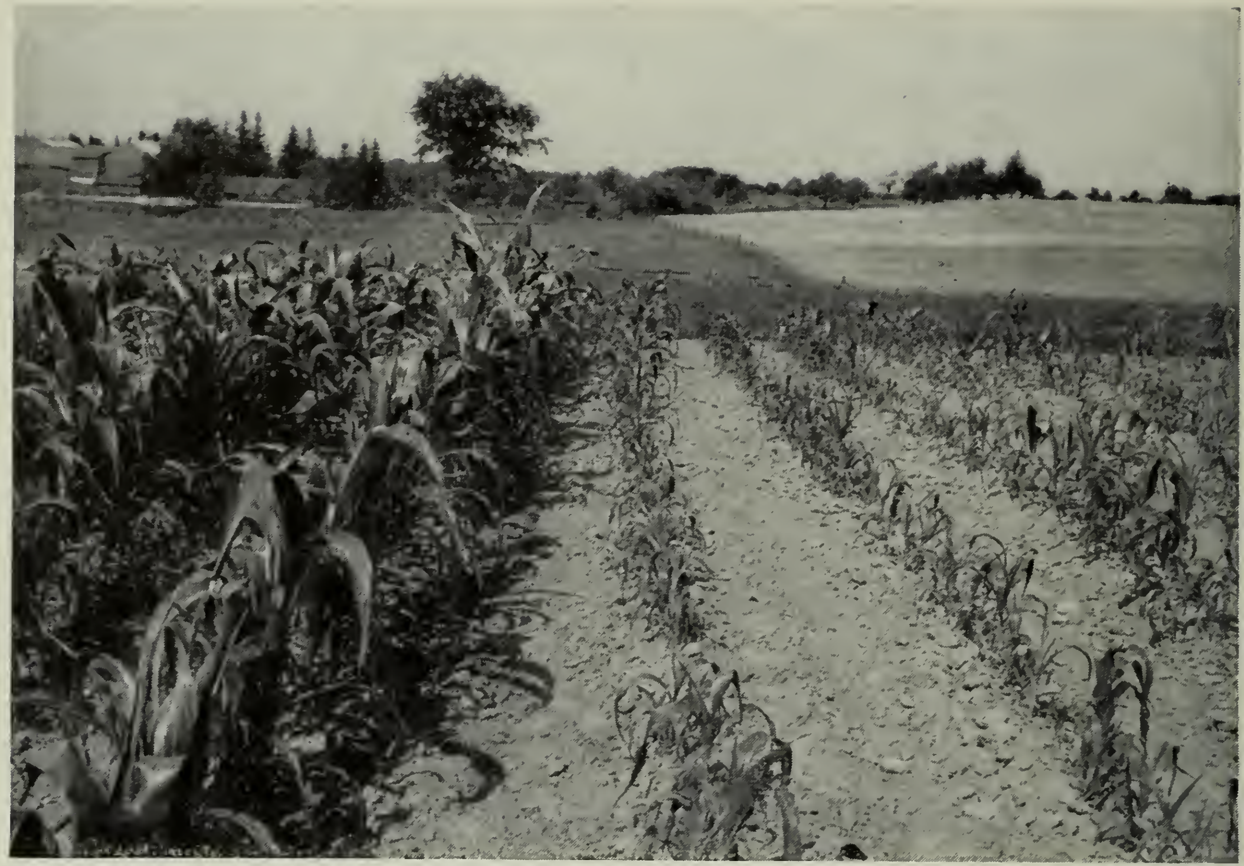
THE EXPRESSION OF SOIL REACTION

The conventional term pH is used to denote the degree of acidity or alkalinity. The pH values for most Ontario soils will fall within the numbers 4.5 - 8.5.

The pH scale of soil reaction for Ontario soils is as follows:

Increasing Acidity ↑
pH below 5.5 — strongly acid soils
pH 5.5 - 5.9 — moderately acid soils
pH 6.0 - 6.5 — slightly acid soils
pH 6.6 - 6.9 — very slightly acid soils

Increasing Alkalinity ↓
pH 7.0 — neutral soils
pH 7.1 - 7.4 — very slightly alkaline soils
pH 7.5 - 8.5 — slightly to moderately alkaline soils.



Fertilizer and manure used on the left.

Good soil management may require the use of commercial fertilizers. Heavy cropping removes more plant food than is supplied by manures, crop residues and the soil itself.

Soils are acid not because of the presence of corrosive acids such as may be purchased in a drug store, but because the clay and the humus of the soil become low in calcium and sometimes magnesium. This gives rise to acid clay and acid humus which are characteristic of acid soils. Clays have a large warehouse, which is like a theatre with many seats. If all these theatre seats are filled with fellows like calcium, magnesium and potassium, the soil is neutral or alkaline. When the plant roots absorb this calcium and magnesium, the vacant seats are, in a good soil, filled with more of these two elements, released from soil minerals. In a soil which does not have a good reserve supply of calcium and magnesium, seats made vacant by root absorption of these elements, or by other means, become filled with hydrogen, causing the soil to be acid. Sands have a small warehouse, or a theatre with only a few seats, but the same principle applies.

The soil test is of special usefulness in determining the need of a soil for lime. For further information on liming the reader is referred to Bulletin 477 of the Ontario Department of Agriculture, Statistics and Publications Branch, Toronto, Ontario. The title of this bulletin is **"Does Your Soil Need Lime".**

FERTILIZER USE

The use of fertilizers becomes necessary when crop response indicates a need for one or more of the readily available nutrient elements.

NITROGEN

When organic matter in the soil is low, available nitrogen is usually low. Legumes plowed down are a good source of available nitrogen. Nitrate nitrogen is not fixed in any way in a soil, and if present in large quantities at any one time is susceptible to leaching. The slow gradual release of nitrate is, therefore, the preferable way to supply a crop. For this reason fertilizers are usually low in percentage of available nitrogen.

When manure is applied to a soil at a rate of ten tons per acre, about 100 pounds of nitrogen would be added, provided the manure were well stored and not strawy. The rate of manure additions should be governed by soil conditions and the nitrogen requirement of the crop to be grown.

Fall sown grains often respond to nitrogen top-dressed in the spring, because in the early spring the soil is cold and the micro-organisms which decompose the organic matter to release nitrate nitrogen are not active. When available nitrogen is low, the plants turn a pale green or even yellow colour, and growth is restricted. Where a field of cereal grain, or any other crop, is yellow because drainage is poor, additional nitrogen will not improve the colour or yields because excess water shuts off the air supply, preventing the absorption of nutrient elements by the plant.

Organic soils, such as the mucks and peats, may not contain as much available nitrogen as the supply of organic matter would imply.

NITROGEN

- **gives dark green colour to leaves**
- **produces rapid growth**
- **increases protein content of crops**
- **feeds organisms while decomposing organic material**

PHOSPHORUS

The total amount of phosphorus in Ontario soils is low. Nature wisely locks it in the soil so that it is difficult to leach out. She rations the available supply by making it soluble slowly and in small amounts.

If the plant root is not in the immediate vicinity to absorb some of the released phosphorus, the soil promptly fixes it again. Thus Nature supplies just enough phosphorus to maintain growth, but insufficient for the high yields of crops which we demand of our soils today. Thus phosphorus additions as a fertilizer can be generally recommended for all Ontario soils.

It has been estimated that up to 50 per cent of the total phosphorus in a soil is present in the organic matter. Since the topsoil contains practically all the organic matter in a soil, it is all the more important to conserve it.

Phosphorus can be applied to soils as fertilizer. The best forms to date are superphosphate or ammonium phosphate. The latter carries considerable nitrogen with the phosphorus.

PHOSPHORUS

- **stimulates early root formation and growth**
- **gives rapid and vigorous plant growth**
- **hastens maturity**
- **imparts winter hardiness to fall-seeded crops**

POTASH

Potash is a variable constituent in Ontario soils. The amount of potash present in soils may appear high, when compared to total nitrogen and total phosphate. Plants require more potash than any other mineral element. Potatoes, sugar beets, turnips, mangels, corn and legumes along with many fruit and vegetable crops have a high potash requirement.

POTASH

- **imparts vigour and disease resistance to plants**
- **encourages stalk stiffness**
- **improves quality of seeds and grain**
- **imparts winter hardiness to fall-seeded crops**

THE MINOR ELEMENTS

The minor elements are usually considered to be boron, manganese, iron, zinc, copper and molybdenum. Of these, only boron appears to be of general interest in Ontario. Some manganese deficiencies have been noted, but they have not been widespread.

Deficiencies of these minor elements in soils are not so widespread as to warrant their general additions to all soils. When deficiencies do exist, they can be corrected by supplemental additions to the soil or as a spray on the crop. The range between beneficial and detrimental amounts is very narrow so they must be carefully used, for too much will cause injury.

SOIL ADVISORY SERVICE

The Ontario Department of Agriculture maintains soil-testing stations where farmers may send their soil samples. There is no charge for the service, but samples should be mailed or expressed prepaid, or delivered personally.

Determinations on each sample are made for soil reaction, water soluble calcium, and magnesium. This assists in the estimation of lime requirement, and assesses the magnesium content which is sometimes low in Ontario soils. In addition, determinations are made for available phosphorus and potassium, and nitrate nitrogen.

Each sample must be accompanied by a completed questionnaire form, in which the farmer states the topography of the field, the drainage situation, the ease of growth of legumes, the rotation practised and the lime and fertilizer used during the past three years. From the results of the analysis of the soil, together with the information submitted by the farmer, recommendations are given for the kind and amount of limestone and fertilizer to use for the specific crop to be grown. Advice may also be submitted on rotations for the farm when deemed necessary. It is very important that soil samples be properly taken. The Agricultural Representatives and the testing laboratories have instruction sheets for taking samples which will be sent on request.

LAND DRAINAGE

Among our good land use practices, artificial drainage, by ditches or tile, is one of the more important requirements of soils which are limited in use by inadequate drainage. Drainage provides a direct means of bringing about the proper use of land in accordance with its capability and of treating this land according to its needs. By increasing production on level land that was wet, the cropping strain on sloping more erodible land is eased. Drainage of the level wet land makes it possible to move erosion-inducing crops from the sloping uplands and to return these uplands to a denser, more protective type of cover.

In dealing with drainage problems one must carefully determine the economic feasibility of drainage schemes. In considering the installation of a drainage system, a farmer should weigh the estimated cost against the expected increases in revenue after drainage. The cost is normally spread over a period of time such that all drainage debts will be sufficiently repaid to assure a sound financial status before maintenance and repair costs develop against the system.

The decision on draining a small or large tract of land is best made after considering:

- **the crops and their cash or feeding value**
- **the soil texture; plastic clays may not drain properly**
- **the stoniness in the surface and subsoil**
- **the availability of good outlets**
- **the proportion of good and poor land in the drainage area**
- **the effect on natural forest cover**
- **the effect on local ground water supplies**
- **the wild life in the drainage basin**
- **the contribution to flood problems farther down the watershed**

Assistance in surveying and planning farm drainage systems is given by the Departments of Agricultural Engineering at the Ontario Agricultural College, Guelph, and at the Kemptville Agricultural School, Kemptville.

SOIL EROSION AND METHODS OF CONTROL

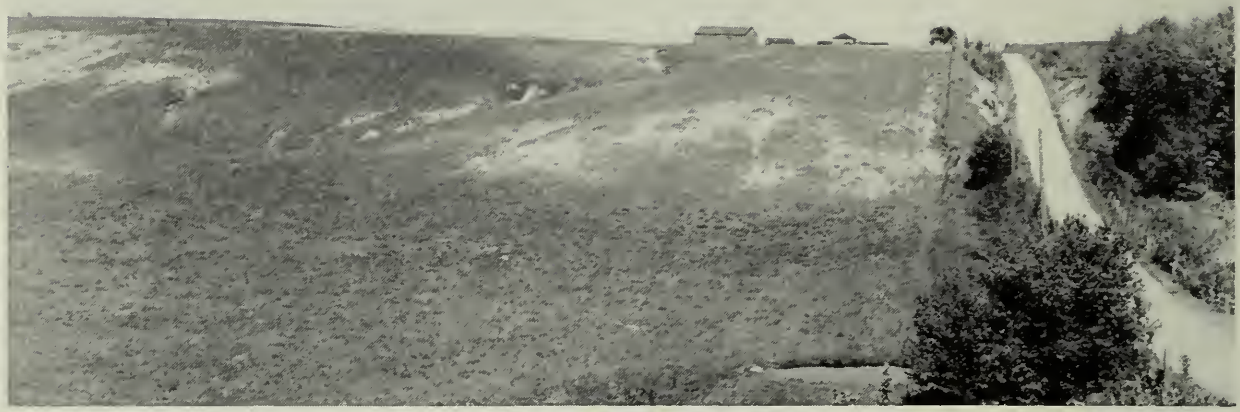
TYPES OF EROSION

Soil erosion may be defined as the wearing away of the land surface by water and wind. When this erosion proceeds faster than the soil is being formed by Nature, the soil becomes progressively poorer. It is this accelerated soil erosion that has become a serious agricultural problem on much land in Ontario.

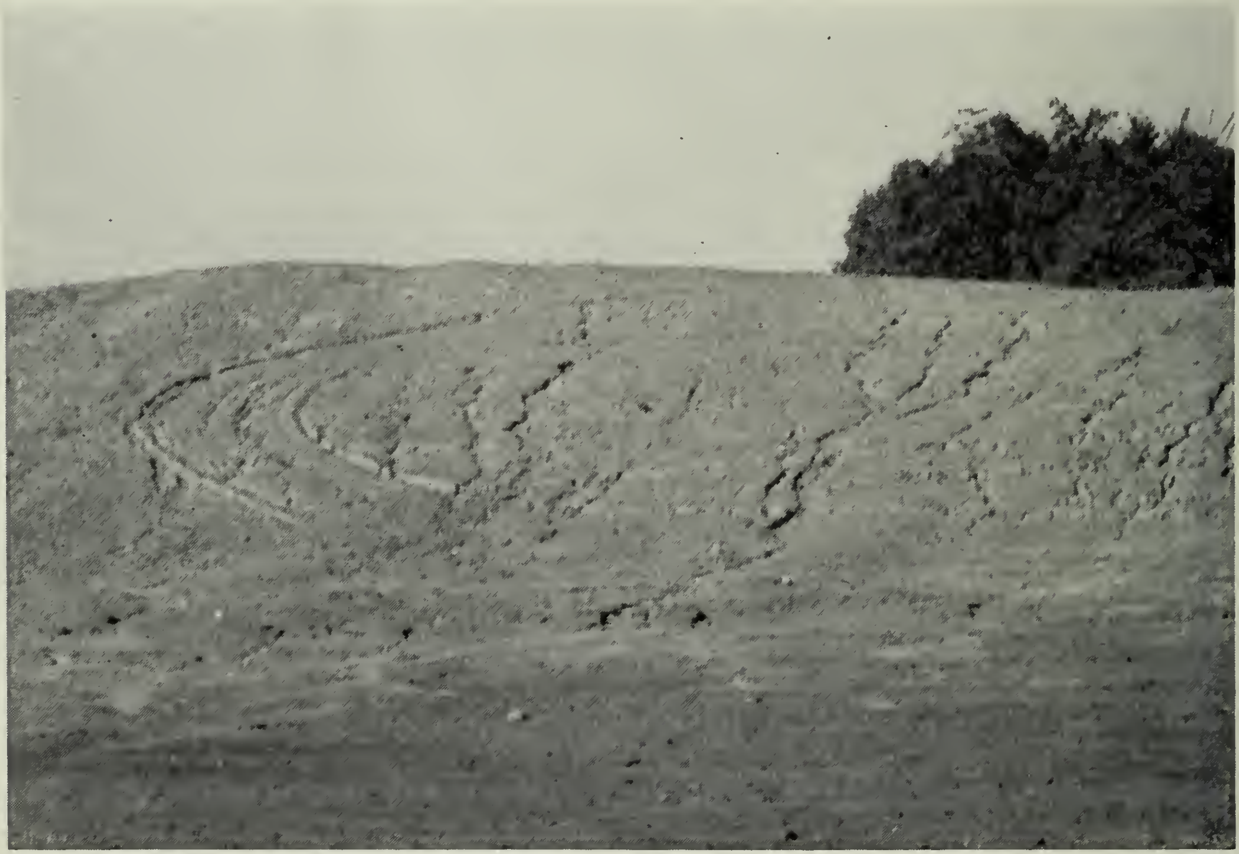
Erosion of soil by water can be divided into three stages, although there is no fine line of demarcation:

- **sheet erosion**
- **rill erosion**
- **gully erosion**

Sheet erosion is a slow persistent wearing away of the soil which may go on for years without giving any warning. It is hard to see, hence it is the most dangerous type of erosion. The farmer appreciates the problem when a patch of greyish subsoil appears on a knoll. By this time the field has lost several inches of valuable topsoil.



Sheet erosion.
As land dries out, the colour differences indicate the severity of sheet erosion. When the grey subsoil appears, all the top soil is gone.



Extensive rill erosion after discing.
Too often the shallow rills are harrowed or disced in and forgotten. A strip of sod along the face of the slope would have prevented the erosion.

Rill erosion is visible. The water digs out small channels a few inches deep as it moves along sloping land. If rill erosion is allowed to proceed unchecked, gullies may eventually develop. Too often farmers rub out the rills by plowing and harrowing and forget about them. Without some control measure the problem becomes worse.

Wind and gully erosion are discussed in more detail on pages 33 and 38.

In fields where sheet erosion is prevalent it is not uncommon to find the crop on the upper slopes maturing before that farther down. Not only does the crop mature earlier but the stand is thin and short. Where the eroded material has accumulated, many crops, especially oats, will lodge and not mature properly.

The Experimental Farm at Ottawa has reported the effect of decreasing the depth of topsoil on the yield of barley and alfalfa. The table that follows shows that barley is more susceptible to thin soil conditions than alfalfa, yet in both cases the yields on subsoils were not encouraging. The difference in the root systems may account for the marked reduction in yield of barley as compared with the alfalfa.

THE EFFECT OF SOIL EROSION ON CROP PRODUCTION

Central Experimental Farm, Ottawa

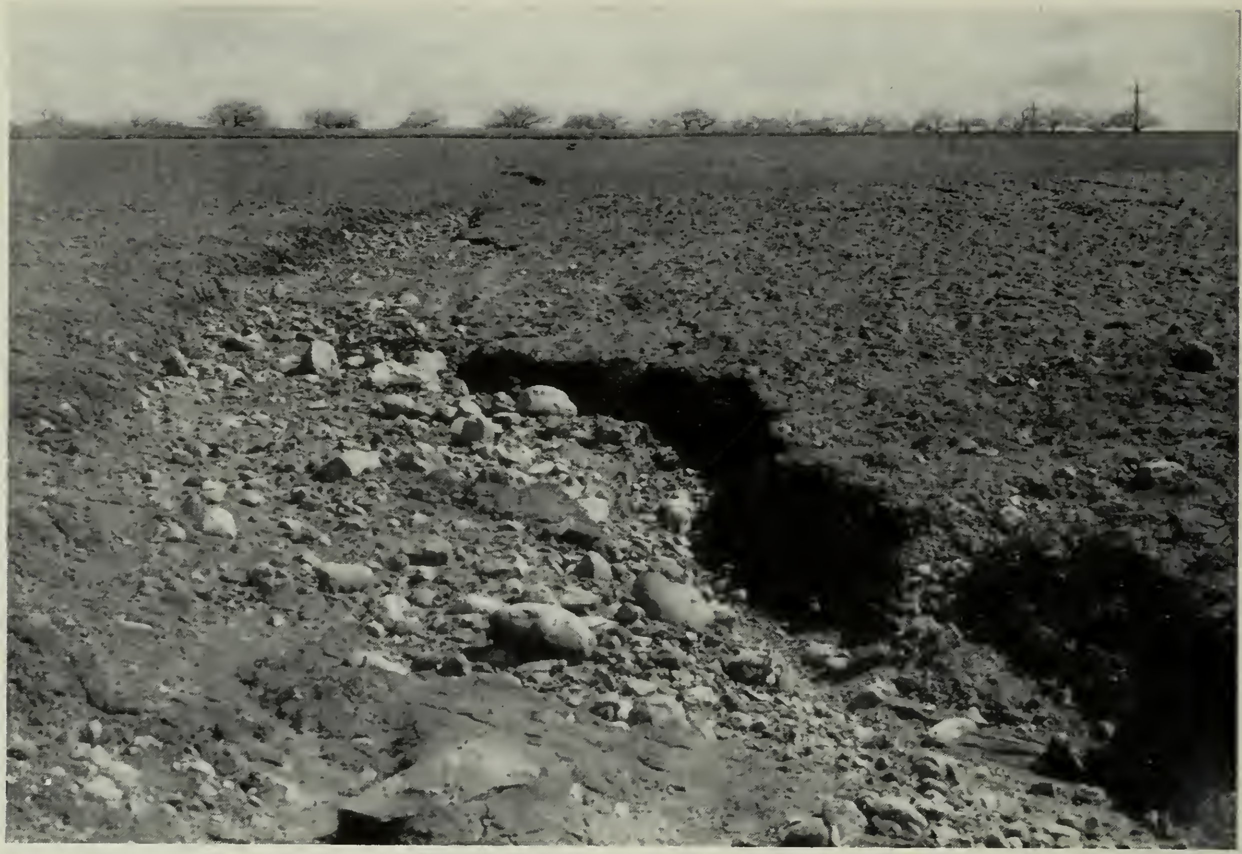
	Barley 7 yr. average Bushels per Acre		Alfalfa 3 yr. average Tons per Acre	
	Fert.	Not Fert.	Fert.	Not Fert.
3″ surface soil added	46.8	33.3	3.24	3.04
Normal undisturbed soil	45.6	33.2	3.07	2.79
3″ surface soil removed	37.1	26.6	2.76	2.39
All but 1″ surface soil removed	24.1	14.8	2.58	1.94
All of surface soil removed	11.7	4.0	1.73	1.44

The above data indicate that:

- **three inches of added soil slightly increased production over the normal soil**
- **as more soil was removed, the production decreased**
- **without topsoil the crop produced was very meagre**
- **in every case the plant food added in the fertilizer encouraged greater production than from unfertilized soil**

FACTORS AFFECTING SOIL EROSION

Many people maintain that an unpastured woodlot effectively controls erosion and that our soil erosion problems commenced with the clearing and breaking up of the new land. Other people believe that some erosion did occur under Nature's plan but agree that farming has in general aggravated erosion problems. Both groups of people maintain that if it were possible to grow a dense vegetative cover on the soil throughout the year, erosion could be reduced to a minimum. It is possible to separate three variables that affect erosion and to show their individual contribution under various conditions.



Shallow gully erosion.

A grass waterway would carry the water, without causing gully erosion, that must flow over this field.

RAINFALL

The total rainfall is not so important as is the rate or intensity with which the rain falls; a heavy rainfall spread over several hours as a drizzle seldom causes serious soil losses. Serious sheet and rill erosion occur with spring rains on land with a frozen subsoil and a soft muddy surface.

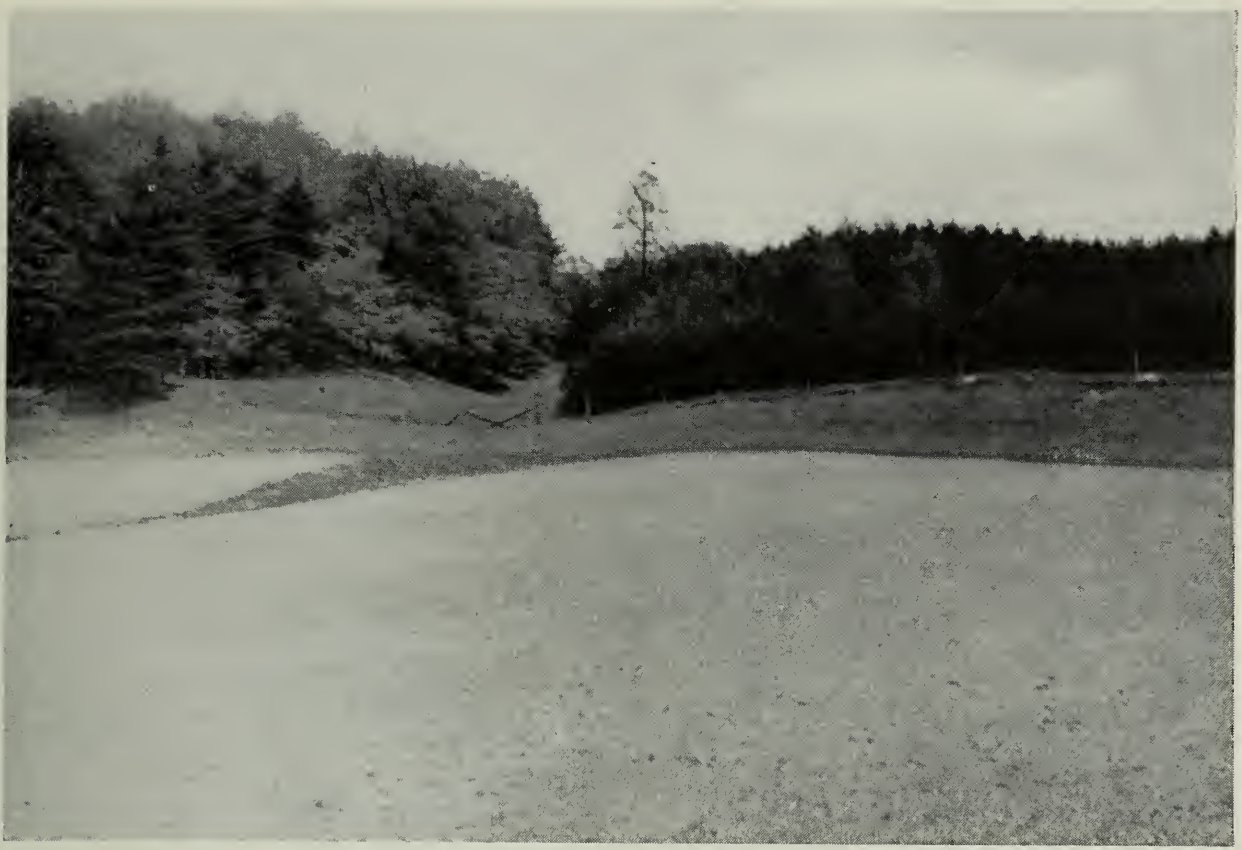
THE EFFECT OF RAINFALL INTENSITY ON SOIL EROSION

(Corn planted up and down a 10 per cent slope)
Central Experimental Farm, Ottawa

Rainfall (Inches)	Duration of Rainfall	Soil Losses in Tons per Acre
2.90	60 minutes	53.5
0.50	10 minutes	6.5
1.98	3 showers, each 30 minutes	18.2
1.29	24 hours	1.4

SLOPE

Another factor that contributes to soil and water losses is the slope of the land. A 10 per cent slope has a fall of 10 feet per 100 running feet. Both steepness and length of slope have an important bearing on soil erosion. It is not necessary to point out that water flows more rapidly the steeper the slope, and if the velocity of the water is doubled, its ability to scour is increased four times; its ability to carry soil particles is increased 64 times.



Intelligent land use.
The steep irregular slopes are reforested with an adjoining strip of hay and a grass waterway. The smoother, less erodible land is worked across the slope.

THE EFFECT OF PER CENT SLOPE ON SOIL EROSION

(for four months, June-October; rainfall 14.9 inches)
Central Experimental Farm, Ottawa

	Soil Loss in Tons per Acre
Corn up and down a 10 per cent slope	77.5
Corn up and down a 5 per cent slope	45.2
Corn on the contour on a 10 per cent slope	28.8

LAND USE

Land use is a broad term. It includes the uses that a farmer may make of tillable land as well as natural woodlots, reforested tracts and unimproved pastures. In the tables that follow will be found a variety of land uses and cropping practices as related to soil erosion losses.

THE EFFECT OF FARM LAND USE ON SOIL EROSION

(average of five years; on a 10 per cent slope; up and down cultivation
for May-October; average rainfall 20.1 inches; from a clay soil)
Central Experimental Farm, Ottawa.

Crop	Soil Losses in Tons per Acre
Summerfallow	26.5
Corn	27.3
Oats	0.7
Alfalfa	0.1

Rough land now retired to pasture.

This land was once regularly cropped but the stoniness, erosion and irregular slopes brought about a change in use which is perhaps more profitable to the owner.

LAND USE AND SOIL EROSION

(on a 14 per cent slope, up and down cultivation; average annual rainfall
38.9 inches; on yearly basis from a silt loam soil)
(1934-1942)
Technical Bulletin No. 888, 1945, U.S.D.A.

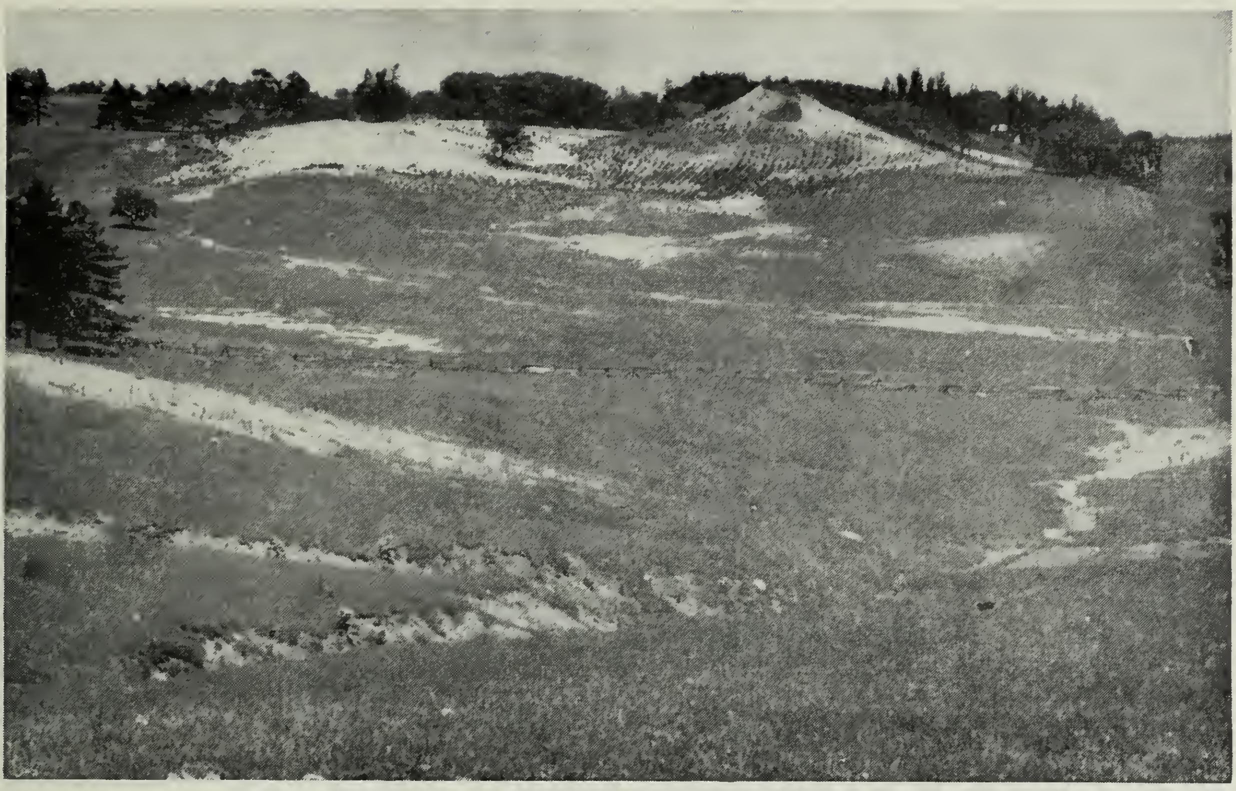
Crop	Soil Losses in Tons per Acre
Continuous corn	99.3
Fallow	96.6
Wild grass	0.3
Bluegrass (fertilized)	0.02
Woodlot (unpastured)	0.01

In a four-year rotation of corn, wheat, hay and hay, the losses according to each crop were:

Corn	41.5
Wheat	11.4
Hay	0.2

On the New Hamburg runoff plots a four-year rotation of corn, oats, hay and hay is followed on a clay loam soil. This project has been in operation since 1948, which does not give an adequate length of time for evaluating the results. For the growing seasons of 1950 and 1951 soil losses from the corn plots, up-and-down cultivation, were less than 1200 pounds per acre per year. The small soil losses from the corn land were attributed to:

1. the place of corn in the rotation—after two years of sod
2. the predominance of large (one-eighth to one-quarter inch) water-stable aggregates
3. the fact that the heavy rains occurred in July at a time when the soil was being cultivated and consequently was porous and retained large volumes of water



A problem in better land use.
This light sandy soil is easily eroded by wind and water. Improved land use practices would suggest extensive reforestation.

The above tables of data indicate that:

- **land in fallow was subject to soil losses equivalent to cropping with corn**
- **continuous corn afforded the soil little protection**
- **in a four-year rotation of corn, oats, hay and hay erosion was materially reduced**
- **hay, well-managed pastures and unpastured woodlots effectively controlled erosion**
- **for a single sharp shower the denser the vegetation the more effective was the control of erosion**
- **the farmer has within his control crop rotations and cultural practices that may reduce erosion**

It is impossible to set down in a one-two-three order the exact measures that a farmer should employ on a farm, field or portion of a field. The combination of measures that will effect a control under the type of farming in York County will not serve as control measures for the type of farming in Essex County. While there is no one remedy or combination of remedies that is applicable everywhere there are three fundamental principles that have a widespread application.

PRINCIPLES OF EROSION CONTROL

To Reduce the Velocity of Runoff Water

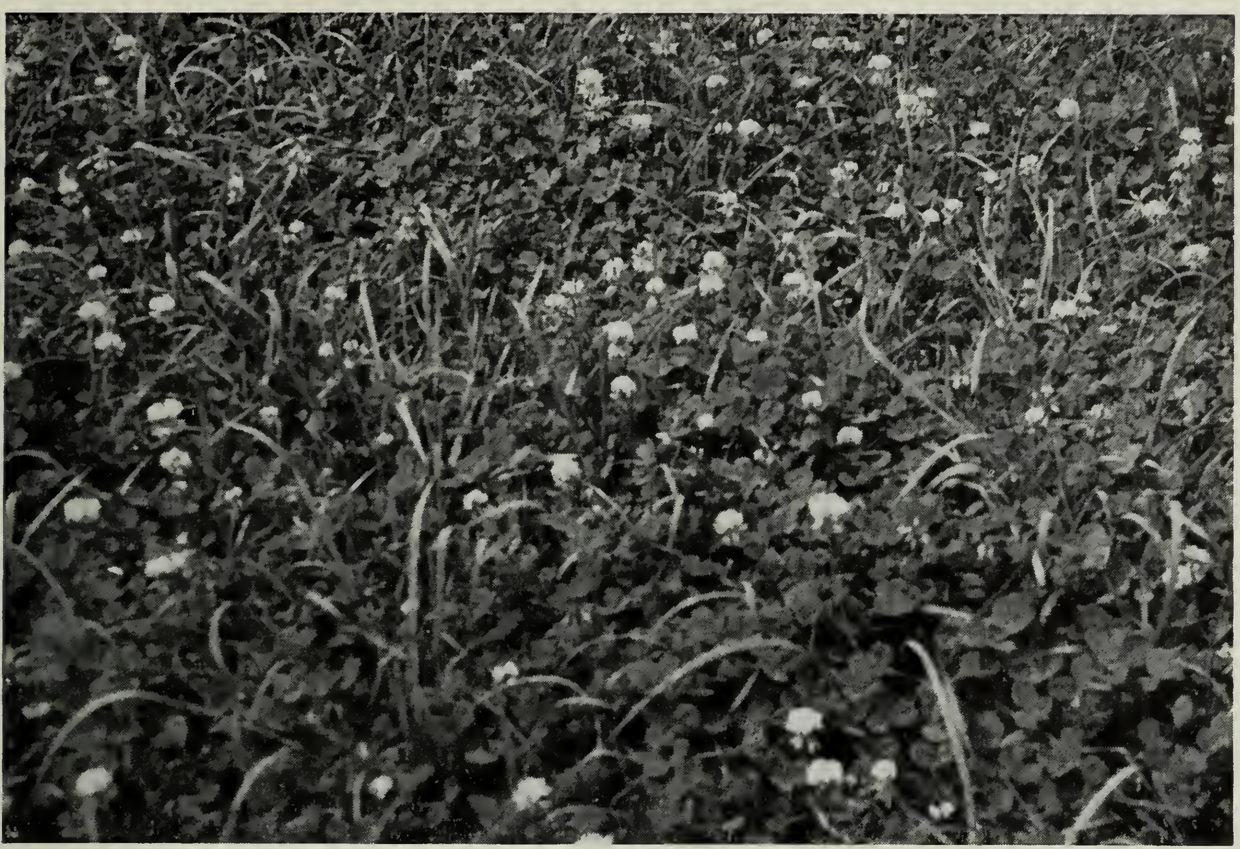
We often hear the expression, "Make the water walk, not run, downhill." The long slopes give water the opportunity to build up a greater

Alternating strips of grain and hay.
The principle in strip cropping is to reduce the velocity of the water moving over the surface.

velocity and hence, increase its ability to erode. If an obstacle is placed in the path of the water, its velocity is reduced; if a multitude of obstacles, as in a hay field, confronts the moving water then the water is required to "walk" or move along at a velocity not likely to cause gullying nor have the carrying power to move great amounts of soil. Such ordinary observations have become the basis of many sound recommendations; the steeper the land, crop with hay or pasture; plant corn on level or nearly level land; cultivate on the contour; long slopes must be broken up by hay strips; use sod waterways where water tends to flow in a definite channel. The farmer has no control over rainfall nor is it economically advisable to change the slope of his land; but he can effect a tremendous control over moving water by the crops he grows and the way he manages the land that grows these crops.

To Increase Infiltration of Water

When a sod field is plowed, the soil is found to have a highly desirable type of structure. Instead of being finely pulverized, floury, or cloddy, the soil appears as small aggregates ranging in size from one-sixteenth to three-sixteenths of an inch. It is a well-known fact that such a soil will take in a tremendous amount of water before it is flooded; it will also drain more quickly and be ready for cultivation earlier than a soil which previously grew corn or grain. The ability of a soil to take in or absorb large quantities of water at a high rate of infiltration significantly affects the erosion that may occur. The farmer cannot change the soil on his farm from a sand to a loam nor from a loam to a clay loam, but he does exert an important control over soil structure by the crops, the rotation and his



Clovers and some grass.
A mixture of clovers and grasses protects the soil against erosion, provides excellent hay or pasture and improves the soil.

cultivation practices. A field of corn after spring grain does not have a stable form of aggregation and if this corn field is subjected to a beating, driving rain, the soft aggregates collapse, smear over and puddle the surface, preventing further infiltration. If water cannot enter the soil surface then it has no alternative but to run off, transporting with it the broken down topsoil.

To Absorb Energy of Raindrops

Any crop or mulch of straw that will absorb the energy of falling raindrops and allow this water to seep into the soil materially reduces the erosion hazard. Where the soil is left bare as in summerfallow or only partially protected by an intertilled crop, soil and water losses are extremely high.

Crop Rotation and Soil Erosion

Crop rotation may be defined as a system of growing different crops in a recurring succession on the same land. Rotating crops is distinguished from a one-crop system or a haphazard order of crops. A systematic rotation for erosion control involves a succession of grain crops, grass and legume crops and intertilled crops.

The crop rotations to be used on any one farm involve a consideration of such factors as: soil fertility, drainage, erosion, climate, weeds and plant diseases, and many economic factors. The crops that are grown and their sequence are frequently dependent on the productivity of the soil. A large part of the value of a crop rotation in erosion control may be judged by its effect on:

1. soil and water losses
2. soil structure
3. organic matter
4. crop yields

If corn or other row crops are to be grown it is better to select the more nearly level land where, with good management and fertility practices, a rotation of corn, oats and red clover may be adequate. Hilly land should be used mostly for hay and pasture and broken only when necessary to reseed. The rotations for each farm must be worked out individually to maintain a balance among grain, hay and row crops according to the capability of the land to produce these crops.

EFFECT OF CROP SEQUENCE ON SOIL LOSSES

(Slope 16 per cent, silt loam soil; average annual precipitation 31.7 inches)
(1932-1940)
Bulletin 452, La Crosse, Wisconsin

Crop Sequence	Soil Loss in Tons per Acre per Year
Corn continuous	89
Corn after soybeans	66
Corn after one year of hay	42
Corn after six years of hay	28
Barley after corn after one year hay	24
Barley after corn after six years hay	10
First year hay	0.75
Bluegrass sod	0.20

The above table indicates that:

- **more hay in the rotation reduced soil losses**
- **the denser the crop, the better the soil was protected**
- **row crops induced greater soil erosion than spring grain or hay**
- **after hay was a preferred place in the rotation for corn; the aggregation effect of the hay tends to stabilize the soil**
- **if five tons of soil loss per acre is considered a significant loss, then on the 16 per cent slope it is doubtful if corn should be grown at all.**

TILLAGE

In using the word tillage, we are referring to the various mechanical operations upon a soil for the purpose of providing soil conditions favourable to the growth of plants. Tillage is more an art than a science, most operators knowing only what they have experienced. Various colleges and experiment stations have tillage experiments under way examining the effect of numerous farm implements on soil properties and crop yields.

OBJECTIVES IN TILLAGE

Tillage has three principal objectives:

- **to prepare a suitable seedbed**
- **to eliminate weeds**
- **to improve the physical condition of the soil**

TILLAGE IMPLEMENTS

The plow is the most widely used implement for the primary preparation of a seedbed. On a heavy soil or on a dense sod the plow is perhaps the most effective and economical implement on a farm at the present time. It turns the soil over, partially loosens it and covers the organic matter. However, there is much controversy over the merits of a plow and other tillage implements.

Clay soils have a high water-holding capacity; water usually penetrates them slowly, and as a result they are frequently worked too wet. Working a clay soil when too wet impairs the physical condition of the soil, instead of a granular structure large clods result. Fall plowing permits the frost to mellow these soils. If the soil is left bare over the winter serious erosion occurs on sloping land. Under such conditions some thought should be given to a tillage operation that does not completely bury the crop residue. These residues act as a mulch to prevent soil and water losses.

Somewhere in between the kind of plowing that wins at the matches and trash cultivation there must be tillage methods applicable to the wide range of conditions found in the problem areas of Ontario.

The disc appears as a farm implement in various forms. In general, the discs do not work as deeply as a plow, leave more residue on the surface, prepare a favourable seedbed after certain crops like soybeans, and are often the basic tillage implement on sandy soils. Discs are widely used in after-harvest cultivation for weed control and in seedbed preparation following the plow.

In certain areas of Western Canada trash farming is successful. Farmers use a cultivator type of implement with attached sweeps. The sweeps are sharp blades that slide underground cutting of all roots, shattering the soil but not turning it over. On sloping soils these implements are reported to be soil- and water-conserving machines because:

1. trash left on the surface acts as mulch
2. water is allowed to soak in
3. conserves more moisture for subsequent crops

Rotary tillage implements thoroughly pulverize the soil and mix the organic matter throughout the entire depth of working. Only a small rain is required to puddle the surface of a heavy soil and almost prevent further entrance of water into the soil. This water has no alternative but to run off, carrying with it the soil already loosened up and very easy to move along. These unfavourable conditions are not critical if a quick-growing crop, like rye, is planted immediately after. A cover crop or a mulching of straw or manure frequently reduces this erosion hazard.

Cultivation, particularly in row crops, is primarily for the purpose of destroying weeds, aerating the soil and temporarily improving the physical condition, as in breaking up crusts. Under the discussion of organic matter it was clearly pointed out that cultivation destroys organic matter. Hence cultivation should be done mainly for weed control and as shallow as practical. On rolling land the amount of cultivation must be kept to a minimum. Generally, a soil after two years of hay or pasture will have less annual weeds and will be in better structural condition than a soil after spring grain. For these reasons it is preferable to have corn follow a sod crop.

CONTOUR CULTIVATION AND CROPPING

Of recent years there has been much talk of "contour plowing" and "contour cultivation." This means plowing and cultivating across or around the slope rather than up and down. A contour is a line connecting points of equal elevation. Therefore, a contour line must be level throughout its length. The objective in this type of cultivation is to leave a series of ridges across the slope so that more of the water will soak in, rather than run off over the surface.

While it may not be practical to plow and cultivate exactly on the contour, it is advisable to work across the slope rather than up and down. It is important that the last operation at seeding time be across the slope. Where it is necessary to grow row crops on sloping land, planting and subsequent cultivation should be approximately on the contour.

Contour cultivation alone is limited in its effectiveness. Any cultivation that is slightly off the contour leaves small depressions on the slope where water tends to accumulate. If there is sufficient runoff to break over the ridges left by the implement, serious rill or gully erosion may result. However, this erosion can be prevented by a grassed waterway.

Contour plowing, seeding, cultivation, etc., become more effective in controlling erosion when combined with a practice of alternating strips of cultivated crops or grains with sod strips. This is known as strip cropping.

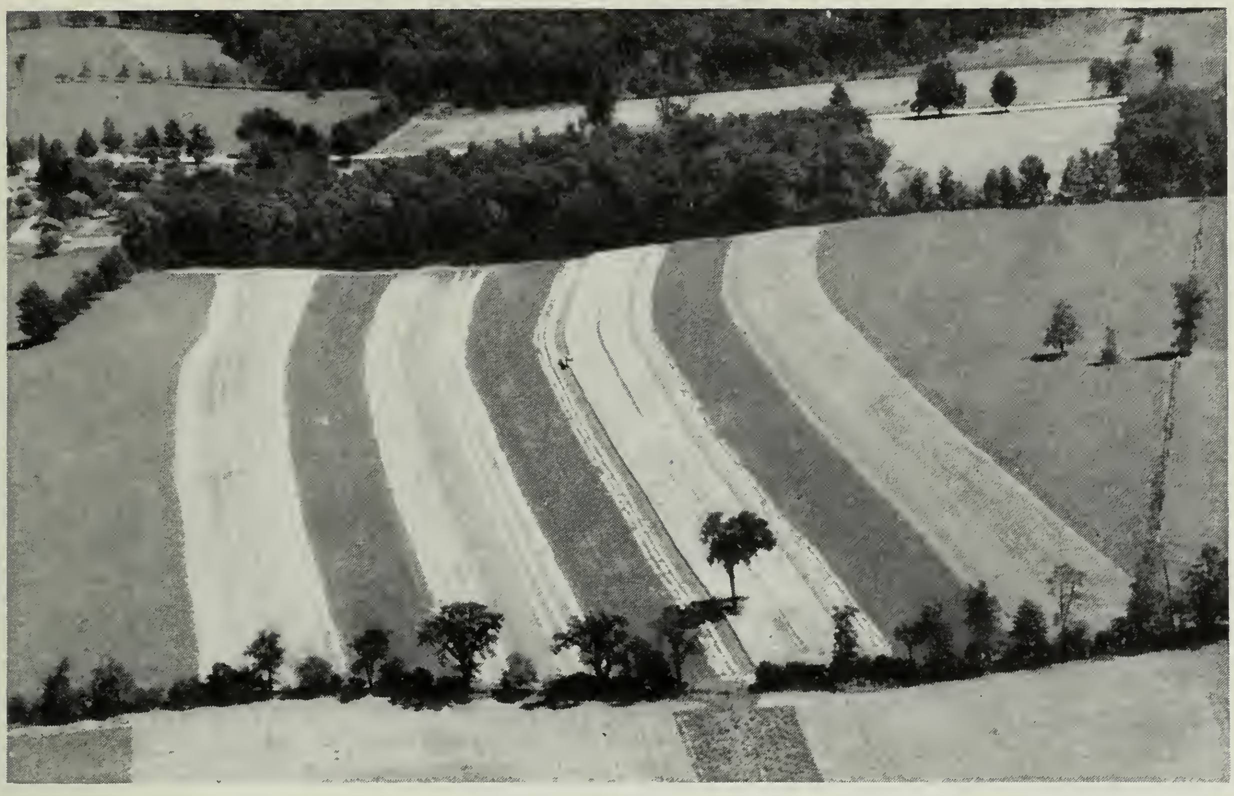
STRIP CROPPING

The practice of strip cropping is an erosion control method which is adaptable on long smooth slopes. It is a means of maintaining strips of sod alternately with strips of grain or row crops, thus increasing the amount of infiltration, reducing the runoff and keeping erosion at a minimum. On some farms it involves removing or changing the location of interior fences to be most practical. The width of strips varies from about 60 to 150 feet, depending on length and steepness of slope, erodibility of soil and the crop rotation. In other words, the greater the erosion hazard the narrower the strips should be.

ADVANTAGES IN STRIP CROPPING

The main advantages of a strip cropping programme are:

- **reduces the velocity of the water**
- **increases the infiltration of the water**
- **holds the soil in place**
- **encourages a definite crop rotation**
- **facilitates contour cultivation**
- **requires less power in operating farm machinery**



A practical erosion control measure.
Strip cropping is an effective erosion control measure on this 8 per cent slope. Each strip is approximately 80 feet in width.

TYPES OF STRIP CROPPING

There are three general types of strip cropping:

1. field strip cropping
2. contour strip cropping
3. strip cropping for wind erosion control

FIELD STRIP CROPPING

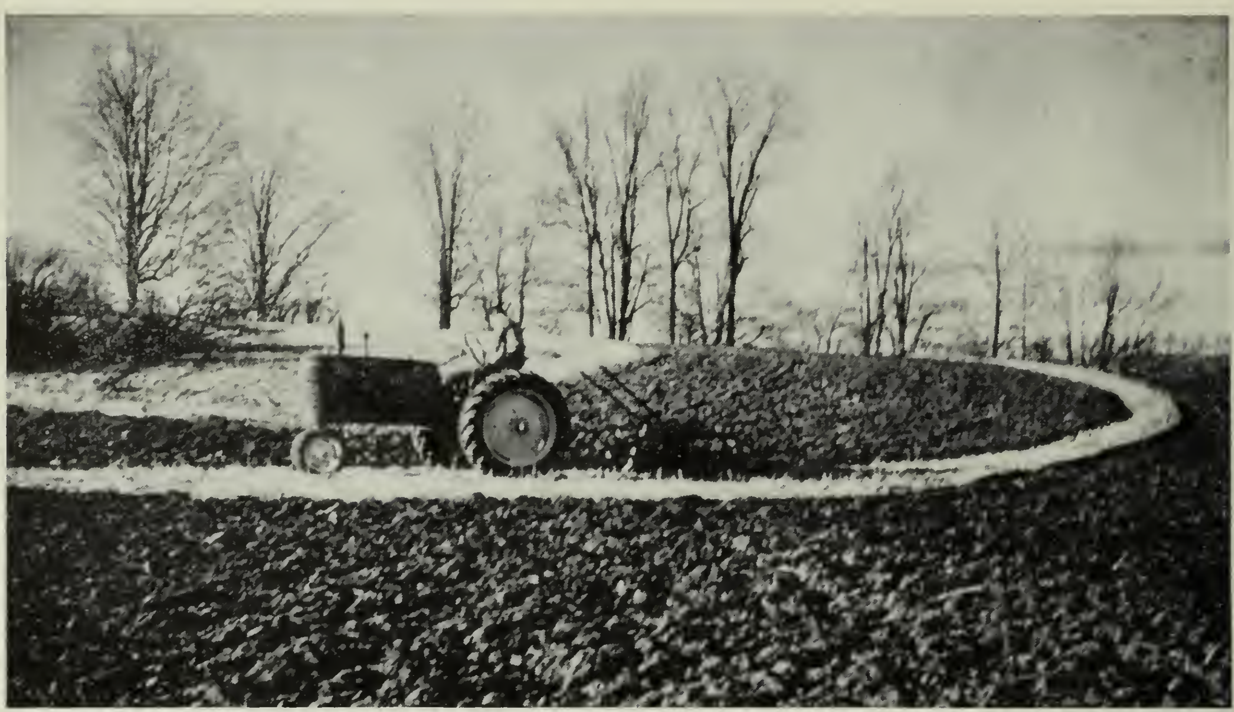
In field strip cropping, the strips are of uniform width and placed across the general slope of the land. The strips are usually parallel to some fence line and do not curve to fit a contour. Field strips are recommended on uniform slopes where it appears that no greater control would be attained by contour strips. On irregular topography where it would be impractical to lay out contour strip cropping, field strips may effect some measure of control.

CONTOUR STRIP CROPPING

There are two types:

1. even width strips, most common
2. uneven width strips, less common

In contour strip cropping, the crops are arranged in strips or bands on the contour insofar as it is practical to operate farm machinery. This results in curved even-width strips with a minimum deviation from the true contour. When both edges of a strip are on the contour the result is strips of irregular widths. This type has not been widely used in Ontario but may occur as a correction strip when the even-width strips are running too far from the true contour.



Plowing a contour strip.

One year plow "out" leaving the dead furrow in the middle of the strip; the next year, turn a back-furrow in the centre and plow "in". This alternate "out and in" plowing prevents the development of boundary or centre ridges.

LAYING OUT STRIPS AND CONTOUR LINES

In laying out a farm or field for this practice, the first step is to select the most critical area on the slope. This is usually the steepest part of the field. After marking this point with a stake, fencepost or tree, etc., a line is run with the aid of a level. This contour is marked with a line of stakes and later scratched in with a plow. The strips are laid out parallel to this line. One man walks in the first furrow and another at the end of a tape or rope, while a third follows with a plow to mark the next line. Each strip is marked out in this manner until the line is no more than 1 or 2 per cent off the contour. When that happens a new line is run with the level and the irregular area left is known as a correction strip. These irregular areas are kept to a minimum and wherever convenient are left more or less permanently in sod.

STRIP CROPPING PROBLEMS

A common misunderstanding of strip cropping is the difficulty of pasturing the aftermath of the hay strips. This can be taken care of in planning the farm. For example, let us consider a four-year rotation of hay, hay, fall wheat and spring grain seeded. The area for these crops can be approximately divided into halves by a fence. On one side would be fall fall wheat with first year hay. The hay aftermath could be pastured as soon as the fall wheat was harvested. On the other side would be second year hay and spring grain seeded. The second year hay would be plowed for fall wheat. The following year pasture would be available on the other half. This practice is looked upon as an emergency measure, not one to be practised yearly. The second year hay aftermath usually provides some growth that should be plowed under, not pastured off.

The question often arises as to what to do about the triangularly-shaped areas which may occur when contour farming is applied to a square or rectangular field. These areas do occur but are usually left, along with wide headlands, for hay.

In plowing strips, two approaches are possible: use the strip as a land and plow around, or strike out with a line of stakes in the centre of the strip.

MULCHING FOR EROSION CONTROL

The application of organic material such as straw, spoiled hay, leaves, sawdust, etc., to the soil surface is known as mulching. The advantages and purposes of mulching are:

- **to break the force of falling raindrops**
- **to prevent soil puddling, allowing clear water to soak in**
- **to reduce soil and water losses**
- **to retard evaporation**
- **to assist in the control of weeds**

Mulches of the type mentioned above are usually restricted to horticultural crops or orchards. With these crops the mulching material is applied to the surface by yearly additions. Mulches may not accomplish their purpose if applied during a dry season when an insufficient rainfall only wets the mulch. The water must be enough to saturate the mulch and enter the soil.

Many farm operations prepare a mulch of one kind or another. With the increase in the use of the combine, the straw is spread and left in the field. This acts as a mulch until such time as it is plowed under or disced in with applications of nitrogen, as discussed earlier. In the section on tillage reference was made to new types of farm equipment that slide under the soil and leave a trash-covered surface. This form of mulching is of particular value in reseeding steep hillsides subject to severe erosion. Mulching may be necessary to satisfactorily establish a dense cover in grass waterways or in gullies.

Manure is often left on the surface to act as a mulch, especially in newly established meadows. While this practice increases the loss of available nitrogen, there may be compensating advantages in the control of erosion and in the improvement of the stand of clovers and grasses.

WIND EROSION

In Ontario, wind erosion or soil drifting is largely a localized problem and is confined to sandy and peat or muck soils. Some drifting occurs on any soil under certain conditions, usually cultivating the soil when very dry and leaving surfaces unprotected in high winds. These conditions are found where summerfallowing is practised.

Except for the shifting sand dunes along some lake shores, the soils now subject to wind erosion were once covered with trees. When these soils, principally sands and mucks, were cleared, broken up and cultivated, the soil organic matter was rapidly depleted and the exposed areas began drifting. Small dunes and "blow-outs" were formed. At this stage the fields or farms were often abandoned, insofar as cultivated crops were concerned.

The principal means of control are:

1. windbreaks
2. strip cropping
3. ground cover

In planting windbreaks it is customary to plant two or more rows of trees, one row a rapidly growing variety like Carolina poplar, and other rows of slower growing spruce, pine or hardwoods. One should make sure that he is using adaptable varieties. Assistance may be obtained from the Regional Forestry Offices.

Strip cropping is used in some tobacco growing areas, where a two-year rotation of tobacco and rye is practised. The rye is tall enough to protect the adjoining strip while the land is being prepared for tobacco.

In parts of Ontario, potatoes are grown on sandy soils. A recommended practice to control soil drifting is to sow a winter cover crop of rye or oats and plow it under in the spring in preparation for grain or other row crops.

The control of wind erosion on muck soils is largely obtained by windbreaks and cover crops.

The Forestry Department, conservation-minded farmers and others have done outstanding work in reclaiming many soil drifting areas by planting with adaptable trees. This problem is comparable to gully control in that preventative measures are eventually more economical. The operator of sandy soils must realize the difficulties involved once the natural soil covering is removed and ultilize effective cultural treatments.

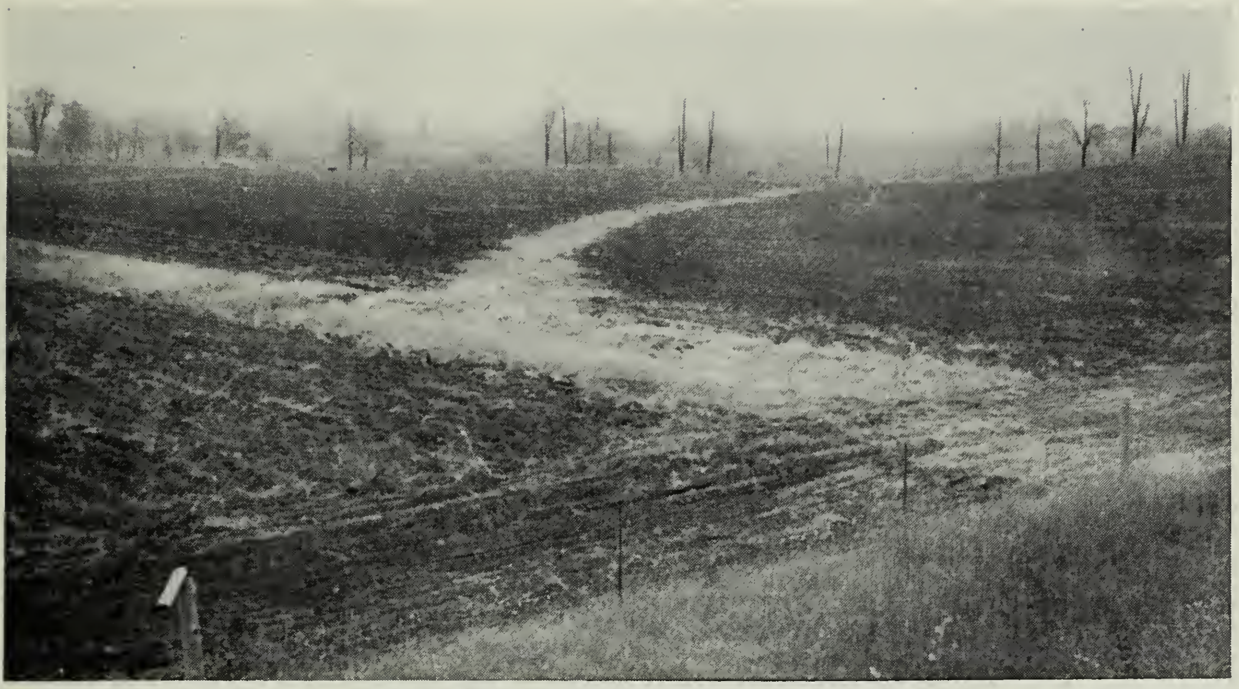
SURPLUS WATER

In the preceding sections various ways and means have been presented for increasing the amount of water that enters the soil. It is generally agreed that if all the water entered the soil, erosion would not be a problem and crops should not be limited in growth by a water deficiency. There are conditions when it is physically impossible for a soil to absorb additional rainfall. Under these circumstances provision must be made for the safe disposal of this surplus water.

Serious gully erosion or flooding may develop when water from adjoining land is not restrained but allowed to flow at will over land at a lower elevation. A farmer is not permitted to construct an obstacle and impound the water on his neighbour's land even though the water came entirely from the neighbours. However, a farmer whose land must carry such water may construct grass waterways, diversion ditches or revegetate gullies, and use these structures to dispose of or spread the surplus water without damaging his own land. On the other hand a conservation-minded and co-operative farmer would discuss with his neighbours or his road superintendent the possible effects his water disposal plans might have on the property under their administration, and so work together.

GRASS WATERWAYS

Grass or sod waterways describe the waterways on sloping land that have been broken up, properly shaped and reseeded to mixtures of grasses



An effective grass waterway.
This waterway carries surplus water without causing gully erosion. Note the irregular edges left in plowing, this prevents small gullies forming on either side of the waterway.

and legumes. Open ditches with steep sides and unprotected subsoil often become clogged up with shrubs, weeds and grasses on many farms. When these channels are cleaned out, shaped and seeded they become grass waterways and utilize the land more efficiently. Unless these established channels are protected by a dense surface cover of grasses, the active erosion continues until the area is impassable with machinery.

Grass waterways are an effective control measure that farmers may utilize. The construction of a waterway is done by plowing, one-way discing or grading out a broad saucer-like channel. The larger the area drained the wider the waterway should be, but a channel less than 20 feet in width is not recommended. Waterways less than 20 feet in width seldom receive the proper attention. The soil is carefully and thoroughly prepared by discing for seeding with a cultipacker seeder. If a packer-seeder is not available, the grass and legumes may be sown with a hand seeder and then rolled or packed. The soil should be heavily fertilized and if possible mulched with manure. Mulching with straw or manure and a light seeding of oats hold the soil in place until the grass becomes established. A waterway may be established in the spring, or in fall when the remainder of the field is in hay. It is a risky undertaking to try to establish the waterway when the field is in corn or grain, because if heavy rains occur unusual amounts of water will run off and wash out the channel.

It is essential that the waterway always be treated as a hay strip by cutting and removing the grass and legumes two or three times a year. The strips must be fertilized regularly, must not be used as laneways and not disturbed by plowing or cultivation.

The seeding mixture should consist of broad-leaved grasses like reed canary and brome and others that make a dense cover, such as creeping red fescue and Kentucky blue, along with ladino or white Dutch clover. It is advisable to avoid bunch grasses such as timothy and the tap-rooted legumes like alfalfa. The waterway must have an effective surface cover that is best obtained with the more shallow-rooted or creeping grasses and legumes.

DIVERSION DITCHES

Diversion ditches, channels or terraces are low embankments of soil thrown up on slopes for the purpose of diverting surface water away from the land farther down the slope. These channels, usually about 30 feet in width, are left permanently in sod regardless of the crops above or below. The sides of the ditches are gently sloped and present no difficulty in hay removal.

The diversion ditches find their greatest use in three major situations:

1. to break up long uniform slopes where strip cropping is not entirely effective
2. to divert water from gullies while being revegetated
3. to protect buildings, structures or property from periodic flooding

Their most effective use is on long slopes where other conservation measures, such as strip cropping, do not adequately control soil erosion. Diversions may be used to divert water from land not under the farmer's control, and avoid flooding or gullying his own land.

Only estimations are given for the conditions under which a diversion might be recommended. A slope of 4 per cent and around 1,000 feet in length may be strip cropped, but beyond 1,000 feet a diversion may be necessary to break up the great length. In general as the per cent slope increases there is a reduction in the length of the slope that may be strip cropped before a diversion is found necessary. Factors like soil and local climatic conditions will materially affect the per cent and length of slope that may be strip cropped without diversions.

A diversion ditch may be built by plowing, disc plowing, grading, or by special machines. The location must be carefully staked out to give a graded channel. This grade varies with soil type, length of channel, type of cover and the area to be drained. If the grade is too steep then erosion in the channel results; if the grade is low then over-topping or break-outs follow. The slope of the channel increases toward the outlet to permit more rapid removal of the water. Where the water will not penetrate or the soil admits water slowly, then the grade should be increased. On long diversions with a moderately tight subsoil, the grade may be as high as 10 inches fall per 100 feet (less than one per cent). On a loamy soil where the water will soak in, this grade may be reduced to 5 inches per 100 feet. The final grade should be established after consulting soils and agricultural engineering specialists who have had experience with a variety of conditions.

It is wise to establish the grass waterway outlets before constructing the diversion channel, otherwise gullies may be formed. The outlet may be into an unpastured woodlot if some attempt is made at spreading the discharge, or perhaps into an old sod field where erosion and gullying will not readily develop. Naturally, the outlet must be placed so as to have no ill effect on the balance of the farm or on neighbouring property.

A well-built diversion ditch.

Diversion ditches are prepared channels across the slope which are kept permanently in sod. They effectively break long slopes.

TERRACES

Terraces have been used in China, Peru, Italy, and many parts of the world for centuries, often in conjunction with vineyards. The modern terrace has been used in America largely within this century and in those areas where the annual rainfall is high, where a large percentage of the crop is intertilled, such as cotton, peanuts, corn and tobacco, and where winter does not stabilize the soil as long as it does in Ontario.

Early terraces were of the bench type, the top nearly horizontal and the front or back very steep. Many lawns have this type of terrace but they are rarely found in modern agriculture. In some parts of the world the bench terrace was faced with stone and the nearly level top planted to grapes. Such structures were used on very steep hillsides, but construction and maintenance costs would be prohibitive in this country.

Modern terraces might be described as a low embankment on sloping land for the purpose of intercepting surface runoff. Many terraces have a graded channel leading to a well-established outlet to safely dispose of the water; other types, the absorption terraces, have a level channel to permit the water to soak into the soil. Terraces are usually found on land with slopes under 12 per cent; if built on greater slopes the interval becomes too narrow for practical farming.

It should be pointed out that terraces are cropped with the rest of the field in the regular rotation. In this respect they differ from diversion ditches or channels, which are left permanently in sod. The graded terrace with a gently sloping channel results in point rows when cropped with corn, potatoes, or other row crops. For this reason a terraced field is difficult to handle for those operators familiar with square or rectangular fields. Provision must always be made for maintenance of the ridge and the outlet channel.

We suggest that farmers who believe terracing will assist them contact soils and engineering specialists who will advise them on the many details of layout, construction and maintenance.

GULLY CONTROL

Gully erosion is often the most spectacular type of soil erosion. Sheet erosion may proceed unnoticed for severals years, but a small gully one to two feet in depth is very prominent and cannot be overlooked, especially when it is necessary to cross the eroded channel with machinery. A farmer may have to spend some time in the spring plowing or discing in gullies; he may leave his grain binder and throw in several sheaves of grain before attempting to cross the gully, or, if no control is begun, the gully becomes a permanent feature of his farm marked by shrubbery, weeds, rubbish, and stones.

Gullies will form in all types of soil, but in Ontario a common location is on sandy soils where intertilled crops like corn, soybeans or tobacco are produced. Extensive gullies have developed in rolling clay land adjoining deep river channels and lake shores. On many farms gullies may develop with one heavy rainfall, especially if the crop is young and the soil loose. If hay or pasture follows in this field then these gullies are plowed in and generally forgotten. When a gully has developed then the situation calls for immediate action to stabilize the soil and prevent recurrence.

Gullies are formed in sloping cultivated land by the concentration of unusually large volumes of water in a small channel. Once a small channel has formed both velocity and volume increase tremendously enabling the water to loosen, scour and carry away topsoil and subsoil.

Wheel tracks made up and down slopes are ideal places for the concentration of water and the starting of gullies. Cattle often follow one path day after day and if the path is developed up and down a slope the vegetation is soon destroyed, leaving the soil suspectible to erosion. Dead furrows, up and down the slope, lead to a collection of water in a narrow channel and with loose unprotected soil severe gullies may develop easily. Many farms, especially on sloping land, are faced with the problem of getting excess water safely away from farmsteads and other areas which have a high runoff. These discharge outlets, unless protected, easily develop into gullies.

A preferred method for gully control is to make some alterations in the direction of the surface runoff by using a diversion ditch to divert the water onto some stabilized surface. The diversion may be a temporary measure while the gully is being filled in, shaped, and reseeded.

A situation may arise where it is not feasible to construct a diversion at the head of a gully and no apparent means exists for handling the water other than down the gully. Under these conditions intensive measures are necessary to reduce the erosive action of the water. A common approach

A large gully now under control.
Many gullies become revegetated when the water is temporarily diverted and livestock are excluded.

is to dump in loads of stones, cut brush or old wire fencing. This haphazard action seldom gives the desired result. The water merely flows around the stones and gouges out an alternate path, or a great volume may accumulate behind an obstacle and when suddenly released create a worse gully than before. Experience has shown that the fundamental approach lies in reducing the speed of the water over the full length of the gully. This may be accomplished by a series of small check dams of logs, boards or sandbags placed across the gully at frequent intervals, with some provision for absorbing the energy of the water when it flows over the top of the dam. It is advisable to place an apron of large stones at the foot of the check dam.

Another method of control is generally referred to as "brushing". Liberal amounts of straw are placed in the bottom of the gully. Brush or shrubbery, 8-10 feet in length, is placed on the top of the straw with the trunk end upstream. The final operation consists of securely anchoring straw and brush by driving in stakes. If willow stakes are used a small percentage, depending on soil moisture, will grow and eventually revegetate the gully. The straw and brush reduce the velocity of the water causing less erosion and allowing whatever soil may be in suspension to settle out and slowly fill in the gully.

Relatively large gullies, such as occur along some lake shores, may be classed as an engineering project. For adequate control the sides must be pushed in and given a more gentle grade, stabilized and planted. Such projects often require masonry or concrete structures to ensure the safety of buildings, roads, etc.

The proper time to control a gully is at the very beginning. A shallow gully one foot deep is easily filled in by plowing, etc., but the soil is very

A farm pond fenced from livestock.

Properly built farm ponds become a supply of water for livestock as well as providing recreation.

loose and more subject to erosion. Prevention begins by careful planning. Avoid concentrating the water in a small channel by spreading it over a stabilized surface, or if the concentration cannot be avoided, provide a properly shaped grass waterway. Often strip cropping, greater use of hay and pasture or grass waterways will prevent gullying.

FARM PONDS

A farm pond is a real asset if constructed so that it will hold water even during the dry seasons. In dry seasons, winter or summer, there are many areas in Ontario which suffer a water shortage. Most common in this respect are the rolling clay plains. Properly constructed farm ponds could help this situation tremendously.

Farm ponds conserve water that may be used for:

- **fire protection**
- **irrigation**
- **livestock**
- **recreation**

In order that a pond be watertight there must be sufficient clay in the soil so that the base and walls of the pond will "seal". A practical method which has been used is as follows: "Take a handful of the soil which will be at the bottom of the pond, wet it thoroughly and make a mud-ball. Slap it against a post and if it sticks go ahead and build the pond."

There are several types of farm ponds such as the dugout, the by-pass —which is near a permanent stream, the spring-fed type, the runoff, and the permanent stream pond. These are all discussed in more detail in a

Reforestation on sandy land.
Light, stony or very steep land unsuitable for agriculture should be reforested.

bulletin on **"Farm Ponds"** prepared by the Department of Planning and Development and reprinted by the Department of Agriculture. It is available from either Department or from the Agricultural Representatives Offices.

Assistance and advice in the layout of farm ponds is provided by the Agricultural Engineering Department of the Ontario Agricultural College.

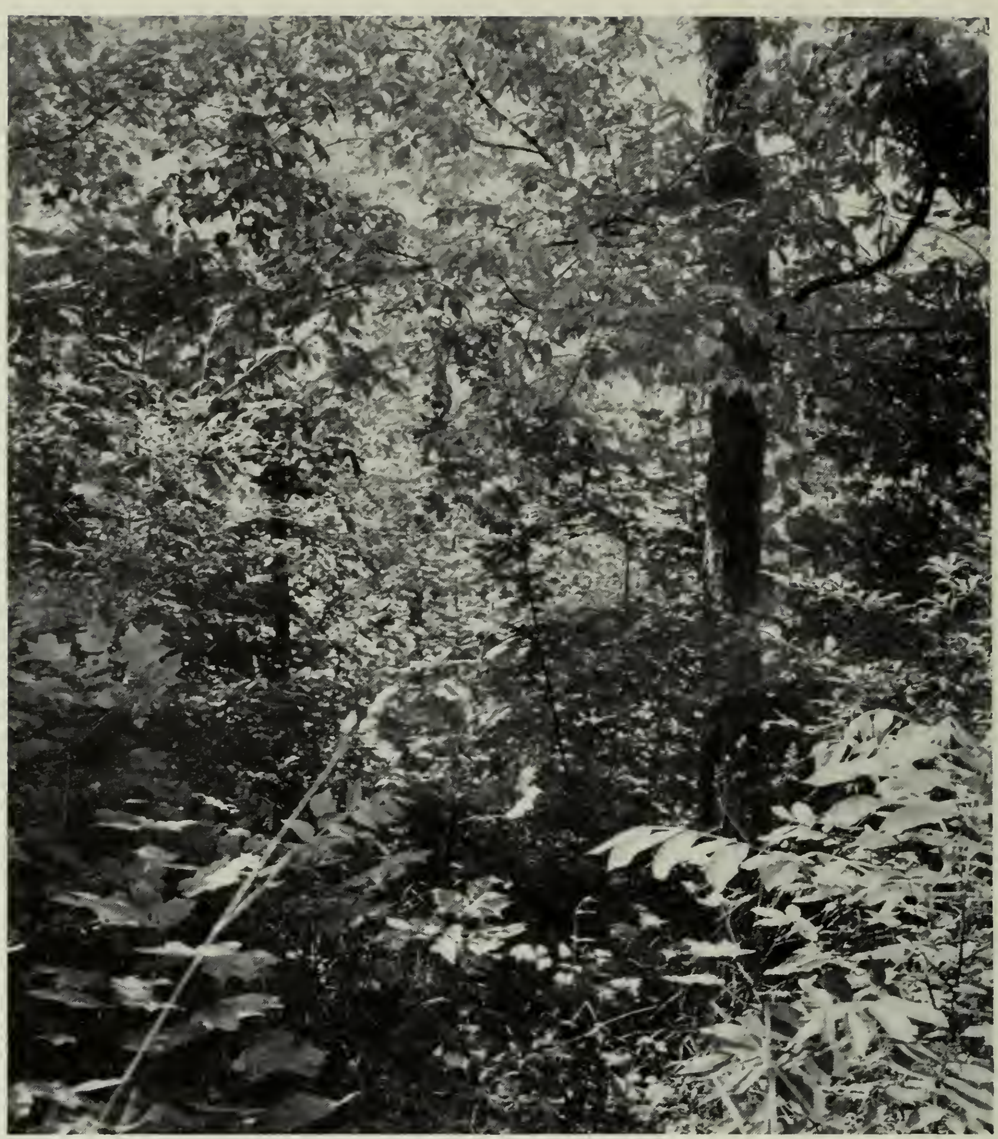
WOODLOTS, REFORESTATION AND WILDLIFE

The interest in farm woodlots and reforestation appears to be greater in the past few years than at any time since the land was cleared. Many areas, which were cleared and cultivated for farm crops, have proven to be unsatisfactory for that purpose and are now being reforested. This applies particularly to sandy soils. There are also many thousands of acres of rough, hilly or stony soils which would produce good stands of timber but are now producing very scanty pasture. These latter soils are costly to reforest.

Some of these rough areas, which have scattered seed-producing trees, would reforest themselves if fenced from livestock. In many pastured areas thorn and wild apple trees have grown up and in some cases almost cover the ground. Where left undisturbed the thorn and apple trees are eventually crowded out by hardwood trees.

Where woodlots are pastured the soil becomes packed and the leaves of young saplings are eaten off. Then as the older trees are cut off the woodlot gradually thins out. Under this treatment the woodlot is not as productive as where the natural undergrowth is allowed to remain.

Farm woodlots are a source of fuelwood, lumber, posts, maple syrup, etc., depending on species. In addition they are important to a community



A woodlot protected from livestock.

When livestock are fenced from a woodlot, the young seedlings are allowed to form a protective cover.

as a windbreak, as an aid in the reduction of the rapidity of runoff, valuable in reducing the severity of floods, a shelter to birds and other wild life, and enhance the beauty of the landscape.

Many bulletins on farm forestry are available on request from the Department of Lands and Forests or the offices of the Regional Foresters.

EDUCATION, RESEARCH AND EXTENSION

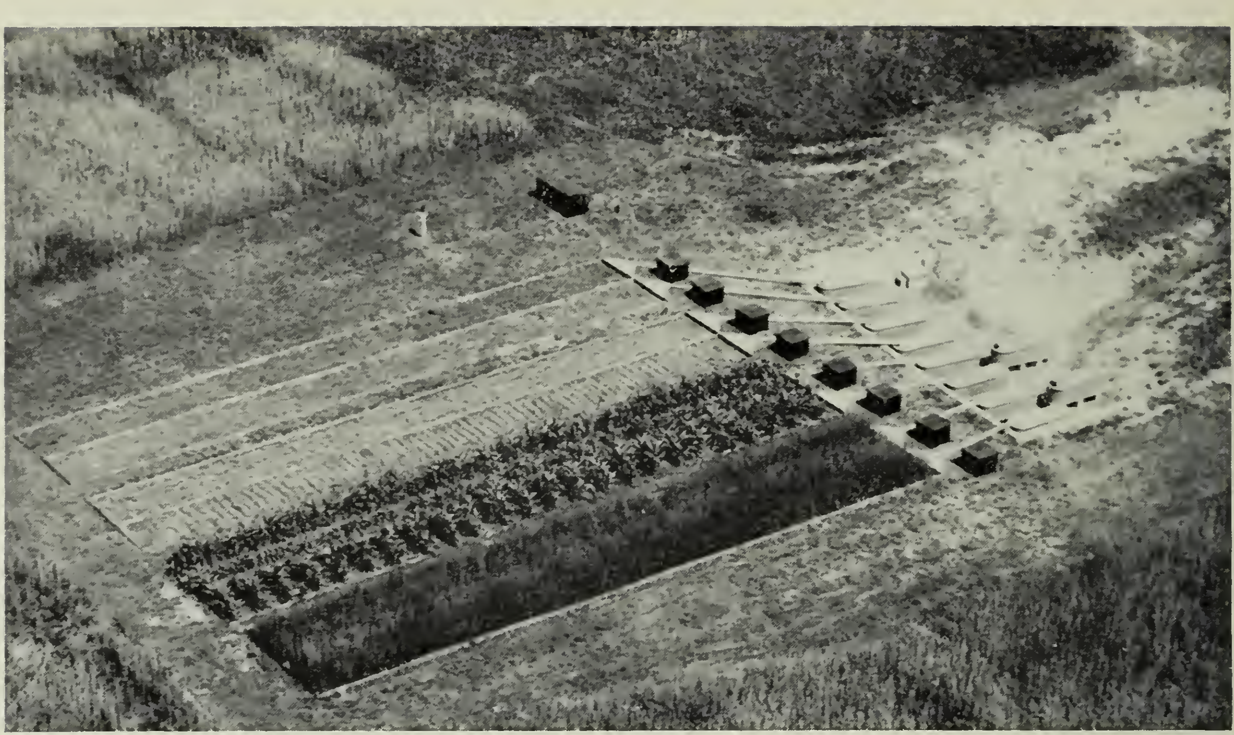
In this bulletin those factors influencing an applied land use programme for Ontario soils have been discussed. Suggestions and recommendations have been made in the full knowledge that a successful action programme must be accompanied by a sound research and educational programme. Recommendations and suggestions have been made for the best possible use and treatment of Ontario soils according to the knowledge that is available at the present time. Continuing research is an absolute necessity to provide answers that will reveal a better understanding of the capabilities and potentialities of our soils. Through continuing experimental and research work in all the fields of soil science a fuller knowledge of our soils will evolve.

A pastured woodlot.

Livestock has been allowed to graze through the woodlot destroying all young growth.

At the half-way mark of the twentieth century considerable interest is being shown in the need for improved land use and soil conservation. Much remains to be done in the educational field. No longer can the urban and rural resident think and act independently of one another. In conserving the soil we are conserving a great natural and national resource. Our people must come to realize that we must develop an intelligent public understanding of the value of natural resources in terms of the individual and of national life.

Accepting the fact that it is a myth to look upon Ontario as a land of unlimited and inexhaustible resources then let us use every means at our disposal to educate all people in the principles of better land use. Beginning with pupils in elementary schools let us impress upon their young keen minds the great need for a genuine interest and pride in our soil resources. The secondary schools, colleges, universities, and organized clubs and societies provide us with the opportunity to stress the principles of improved land use and soil conservation. Modern methods of communication and visual aids permit reaching the majority of our people through an educational programme. In developing a philosophy of land use we must not fail to emphasize that in practising good land use and soil conservation we are not only conserving a great natural resource but are also protecting a way of life, liberty and happiness.



The erosion plots near New Hamburg.

Research is a necessary part of soil conservation if the best results are to be achieved. All the soil and water lost from each plot is caught in the tanks. From such research the effects of crops and methods of planting on soil and water losses are evaluated.

TITLES OF REFERENCE READING

BOOKS:

Conservation in Canada, by O. M. McConkey. Dent. 1952.

Conservation of the Soil, by A. F. Gustafson. McGraw-Hill. 1937.

Elements of Soil Conservation, by H. H. Bennett. McGraw-Hill. 1947.

Field Crops, by H. S. Rather and C. M. Harrison. McGraw-Hill. 1951.

Fundamentals of Soil Science, by C. E. Millar and L. M. Turk. Wiley & Sons, 1943.

Nature and Properties of Soils, by T. L. Lyon and H. O. Buckman. MacMillan. 1947.

Soil Conservation, by H. H. Bennett. McGraw-Hill. 1939.

PERIODICALS:

Journal of Soil and Water Conservation. Published quarterly by the Soil Conservation Society of America, Watson Bldg., Fairmont, West Virginia, U.S.A. (a periodical covering the current American problems in soil and water conservation).

BULLETINS, PAMPHLETS, MAGAZINES:

Canadian farm magazines frequently carry articles on various phases of soil conservation.

Technical bulletins may be obtained from the various colleges and Departments of Agriculture in Canada and the United States.

Machinery companies publish various articles and loan films on phases of soil conservation.

Various bulletins, pamphlets and extension circulars from the Statistics and Publications Branch, Toronto, Ontario.

MOVIE FILMS:

Appropriate films are available through the National Film Board, machinery companies, Agricultural Representatives and the Ontario Agricultural College, Guelph.

BULLETIN 493 DECEMBER, 1952

DAIRY HUSBANDRY IN ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

FOREWORD 4

MILK PRODUCTION IN CANADA 5

MILK PRODUCTION IN ONTARIO 5

ESTABLISHING AND IMPROVING A DAIRY HERD 8

HERD FEEDING AND MANAGEMENT 12

Nutrient Requirements of Dairy Cattle 12

CHARACTERISTICS OF FEEDS 19

Grains, By-products and Concentrates 19

Roughages 20

COMPOSITION OF FEEDS 23

RULES FOR FEEDING DAIRY COWS 27

Stable Feeding 30

Summer Feeding 31

Amount of Concentrates to Feed on Pastures 32

Feeding the Cow During the Dry Period 35

Formula for Dry and Fitting Grain Mixture 36

FEEDING AND CARE OF THE CALF 37

FEEDING AND MANAGEMENT OF THE BULL 44

MILKING PROCEDURE 46

HERD HEALTH 47

HOUSING THE DAIRY HERD 58

Planning the Stall Barn 59

Planning the Loose Housing System 63

DAIRY HUSBANDRY IN ONTARIO

This bulletin was prepared by a Committee consisting of:

Prof. G. E. Raithby, Department of Animal Husbandry, Ontario Agricultural College, Guelph;

W. P. Watson, Live Stock Commissioner, Ontario Department of Agriculture.

Dr. H. D. Branion, Professor and Head of Department of Nutrition, Ontario Agricultural College, Guelph;

Prof. C. G. E. Downing, Head of Department of Agricultural Engineering, Ontario Agricultural College, Guelph;

Mr. A. M. Barr, Principal, Kemptville Agricultural School, Kemptville, Ontario;

Dr. J. A. Henderson, Professor and Head of Clinical Division, Ontario Veterinary College, Guelph.

FOREWORD

Profit has been defined as the difference between the returns received from the sale of a product and the cost of materials and services expended in producing it. That definition has a particular significance in the case of dairy products because of a relatively large number of markets available for milk, each characterised by a different pricing formula, and the great variation in cost of production prevailing throughout the Province. This bulletin has been prepared for the purpose of providing the reader with information about the dairy industry generally and those factors which influence cost of production in particular. Since many of those factors can be controlled by the individual most of the space is devoted to a discussion of problems associated with production.

DAIRY HUSBANDRY IN ONTARIO

MILK PRODUCTION IN CANADA

Between 1939 and 1950 milk production in Canada ranged between 15.2 and 17.3 billion pounds annually. In all of those years production was sufficient to meet domestic demand for dairy products and still leave a nominal amount for the manufacture of some export products. Most of the surplus milk was made into cheese and sold in Great Britain, while lesser quantities were processed into concentrated milk products and merchandized in various parts of the world. During those years Canada's population increased by over two million people. Milk production did not expand at the same rate, hence, in 1951 the 16.3 billion pounds produced was insufficient to meet the demands of the Canadian people. While approximately twenty-four million pounds of cheese were exported, very substantial quantities of butter and cheese were imported. The quantity of milk required in making imported products exceeded the amount used in manufacturing the cheese and concentrated milk products that were exported.

Utilization of Milk in Canada

As a result of Canada's increased population there has been a sharp adjustment in the utilization of our total milk supplies. The following table serves to illustrate this point:—

TABLE NO. 1. PERCENTAGE UTILIZATION OF TOTAL MILK IN CANADA
1935 - 1950

Method of Utilization	Average 1935-39	Average 1943-47	1949	1950	1951
	— per cent of total milk production —				
Fluid sales *	18.8	23.1	24.4	25.5	25.8
Consumed on farms	11.3	9.9	9.9	10.3	10.0
Creamery butter	39.0	39.5	38.9	37.4	36.82
Dairy butter	14.2	7.4	7.4	6.7	6.63
Cheddar cheese	8.9	10.4	7.8	6.6	6.2
Concentrated milk	1.7	3.6	4.0	4.5	5.2
Ice cream	0.9	1.5	2.6	2.6	2.8
Fed to livestock	5.2	4.6	5.0	6.4	6.4

* Includes sales of fluid cream.

It is significant to note that a higher percentage of Canada's milk is now utilized for fluid consumption and for the manufacture of concentrated milk products. This trend is in keeping with the demands of a growing population. Since this growth has been confined almost entirely to the towns and cities it is only natural that more fluid milk should be consumed. Some of the increased population is located in the hinterlands of the north country, far removed from areas where milk can be produced economically, so their citizens must rely on a concentrated product for their milk supplies. The increased demands for these products have been met by drawing on supplies that were formerly destined for use in making butter or cheese.

MILK PRODUCTION IN ONTARIO

In 1951 Ontario produced 5.4 billion pounds of milk, or about one-third of Canada's total. Inasmuch as 1.6 billion pounds, or 29.6 per cent were sold as fluid milk, sales made by Ontario dairymen in this form were well above the average for the country. During 1951 Ontario was the leading Province in cheese production with 63.0 million pounds out of a total for Canada of 85.2 million pounds. The Province also ranked first in the production of concentrated milk products with about 51.89 per cent of the Country's total. On the other hand, Ontario took second place to Quebec in the production of creamery butter, her total being 66.9 million pounds as compared with the 92.0 million pounds produced in Quebec. Ten years ago it was possible to present a fairly accurate record of the number of producers engaged in each type of milk production. However, with the shifting markets, particularly in recent years, it is almost impossible to do so today. Producers who were cheese factory patrons a few months ago may now be marketing their milk through some other outlet.

The Fluid Milk Market

Many dairymen aspire to become whole milk shippers because the fluid milk market has almost invariably paid the highest price. In Ontario some measure of control has been exercised over the industry by a Milk Control Board which administers the Milk Control Act. Committees representing producers bargain collectively with similar committees from the distributors' organizations, from time to time, on matters pertaining to prices and terms of contracts. Agreements reached by these bargaining committees become effective when filed with the Board and are binding upon all producers and distributors operating within that particular area. When agreements cannot be reached matters in dispute are settled by arbitration by the Milk Control Board after public hearings have been held.

Practically all agreements and arbitration awards provide for the purchase of milk by distributors from producers on a quota basis, with the quotas being established by a committee of producers appointed for the purpose. The quotas for all producers shipping to a dairy are set in relation to that dairy's milk requirements. The dairy must pay for the amount of quota milk supplied or the amount received and sold as fluid milk, whichever is the greater. In the event that a producer ships milk in excess of his quota and that milk is not used for fluid sales it is paid for at a secondary or lower price as provided for in the agreement or award. Reviews are constantly being made to improve the contracting and pricing of milk.

Whole milk shippers are required to supply a high quality product in uniform amounts. In order to do so they must keep the cattle and stable clean and the milk house and milking equipment in a sanitary condition. Pigs or chickens cannot be kept in that portion of the stable used for housing the milking herd. Milk must be properly cooled as soon as possible after it is produced and kept at a low temperature until it leaves the producer's premises. Herds must be kept up to the size required for producing quota allotments, but not so large that surpluses are likely to be produced.

Concentrated Milk Markets

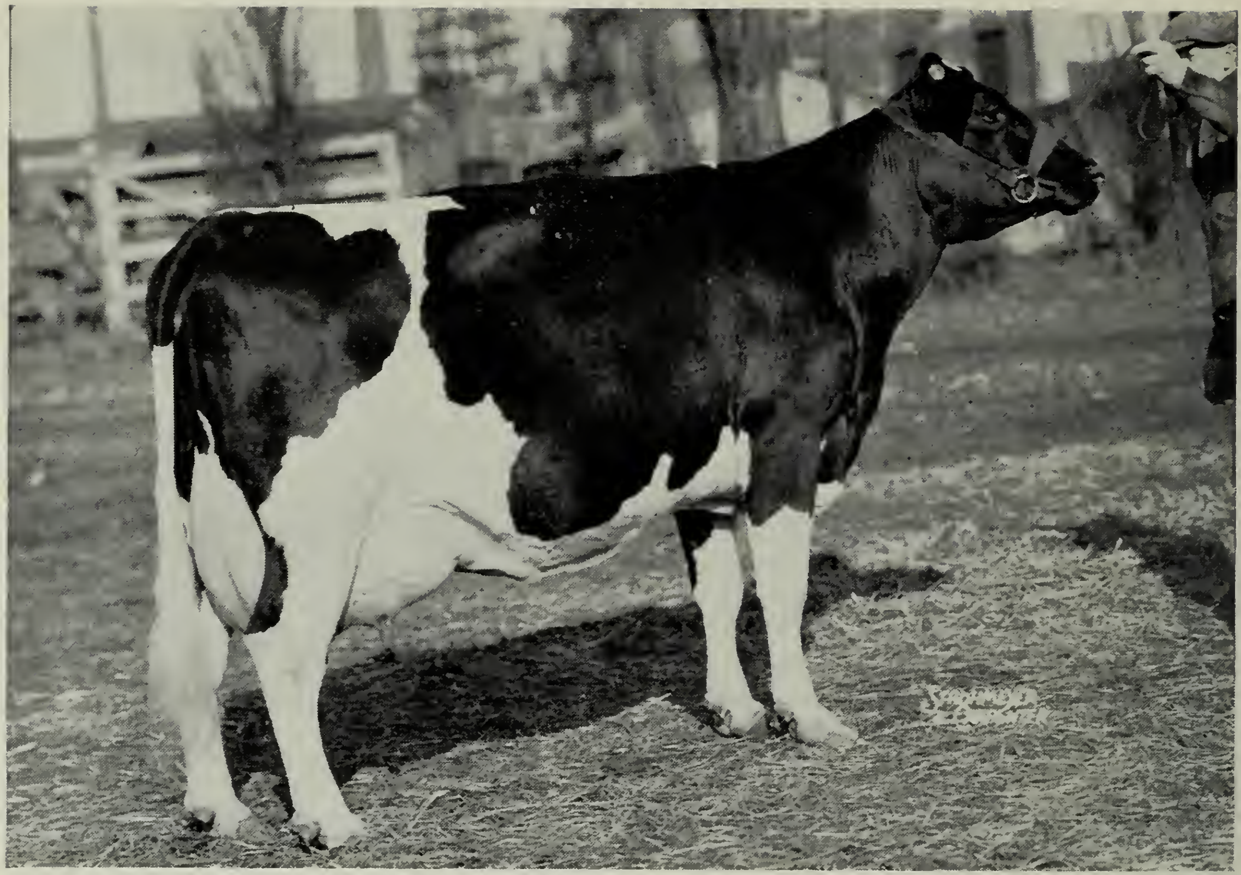
The term "concentrated milk" includes evaporated whole milk, condensed whole milk, dry whole milk, and dry skim milk. Of these products evaporated whole milk is the most important since over 70 per cent of the milk supplied to concentrated milk plants is used in its manufacture. The principal areas of production are in and around Oxford and Elgin counties in Western Ontario and in most counties in the Eastern part of the Province. The price for milk used in concentrated milk products is established by collective bargaining or arbitration, and the basic price is invariably lower than that established for fluid milk. Prices are based on milk testing 3.5% butterfat and milk testing higher or lower is bonused or discounted in accordance with an approved schedule. Producers are not subject to quotas but must deliver a clean, high quality product.

Cream Production

More of Ontario's milk is used in the production of cream than for any other dairy product. A high percentage of this is produced by farmers, with grade beef or dual-purpose herds, who place a high value on skim milk for the feeding of calves, pigs and chickens. Cream is bought according to grade as well as butterfat content, and patrons who supply the best product receive the highest prices. Peak production occurs between May 15th and July 15th when pastures are usually most productive. Nevertheless, in some sections of the province production extends over the entire twelve months. Butter prices are not only subject to all the vagaries associated with the law of supply and demand but must also bear a relationship to other products.

Cheese Production

Because of higher prices usually paid for milk sold on other markets, cheese production has been declining. However it still provides an important outlet for milk produced in Oxford and Perth, and in most counties of Eastern Ontario. Production is seasonal, with many factories opening in April and closing about the end of October. Cows owned by patrons are bred to freshen in the late winter or early spring, and usually go dry at the end of the pasture season. As a consequence, practically all cheese is produced during the period when cows are on grass, and for this reason it is reasonable to assume that cheese factory patrons have a lower cost of production than prevails in those herds where milk must be produced throughout the entire year. Recently a system of rejecting poor quality milk was instituted, and since then producers have found it advantageous to pay more attention to the sanitary conditions. In the past cheese has been produced in excess of domestic requirements, hence the export price has largely determined the domestic price.



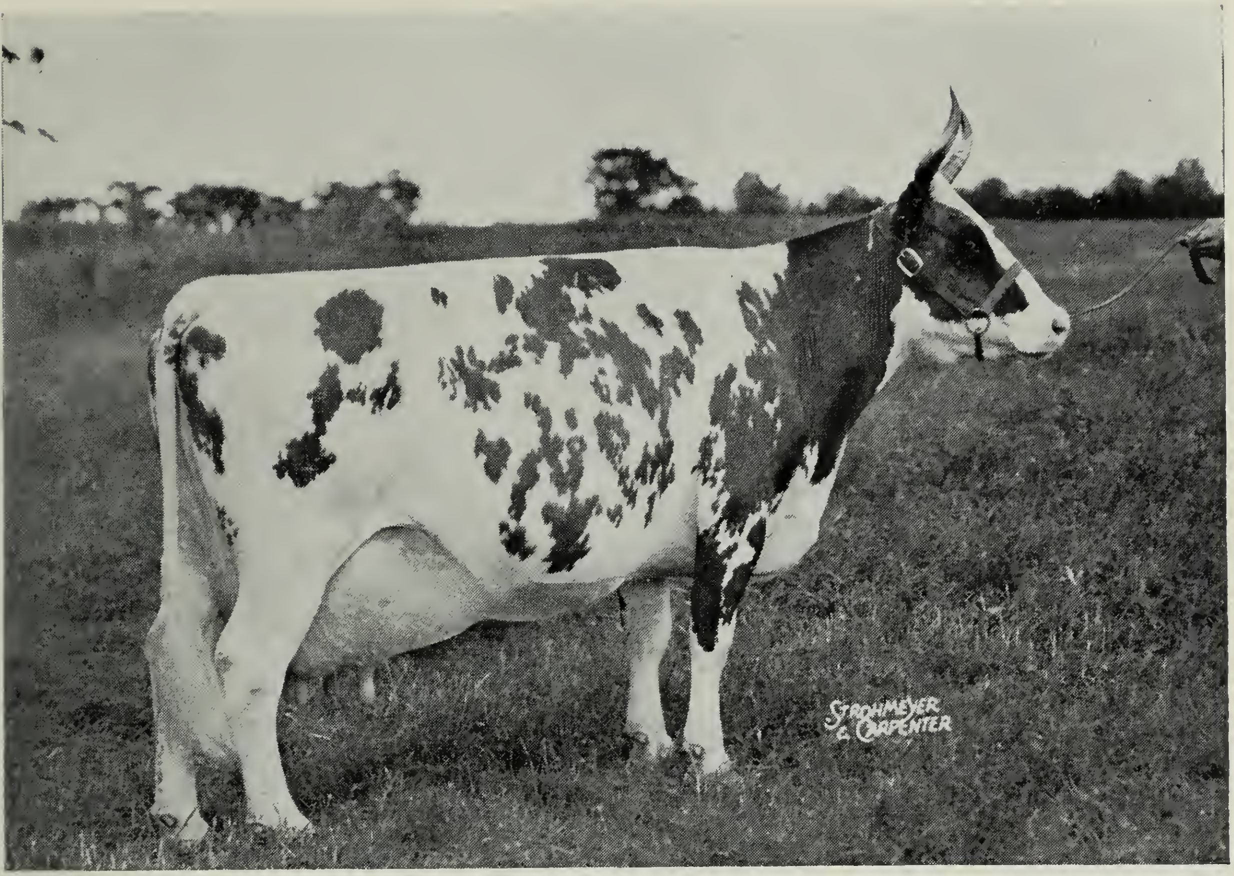
A HOLSTEIN COW

This picture illustrates Holstein characteristics and dairy type. The head is stylish, clean-cut and alert, the shoulder blends smoothly into the body, which is deep and capacious. The back and loin are straight and strong, the rump level, and the tail head reasonably smooth. The udder is capacious, well attached fore and rear, and prominent veins are shown on the udder and body. The legs are well shaped with good quality bone.

ESTABLISHING AND IMPROVING A DAIRY HERD

Most Ontario dairymen derive the greater part of their income from the sale of milk or milk products, exceptions being confined to those patrons who have established high class pure bred herds. Nevertheless a great many commercial dairymen have been able to supplement their returns from milk by selling surplus cattle either to local buyers or for export. In recent years exports of dairy cows and heifers have ranged from 50,000 to slightly over 100,000 head annually with most of the shipments going to the Eastern States where dairymen prefer to purchase replacements. As long as this demand continues Ontario dairymen would be well advised to conduct their operations in such a manner as to capitalize on this market.

Any person planning to establish a dairy herd must of necessity give careful consideration to the choice of a breed. Holsteins are most numerous, probably because dairymen have been impressed by their high producing ability. Representatives of this breed hold many of the world's production records. Ayrshires have many loyal admirers, particularly in Eastern Ontario. While they do not produce as much milk, it usually has a higher butterfat content. Where markets for special high testing milk are available opinions are divided between Jerseys and Guernseys. Cream shippers who plan to supplement their incomes from the sale of beef are partial to Dual-Purpose Shorthorns.



AN AYRSHIRE COW

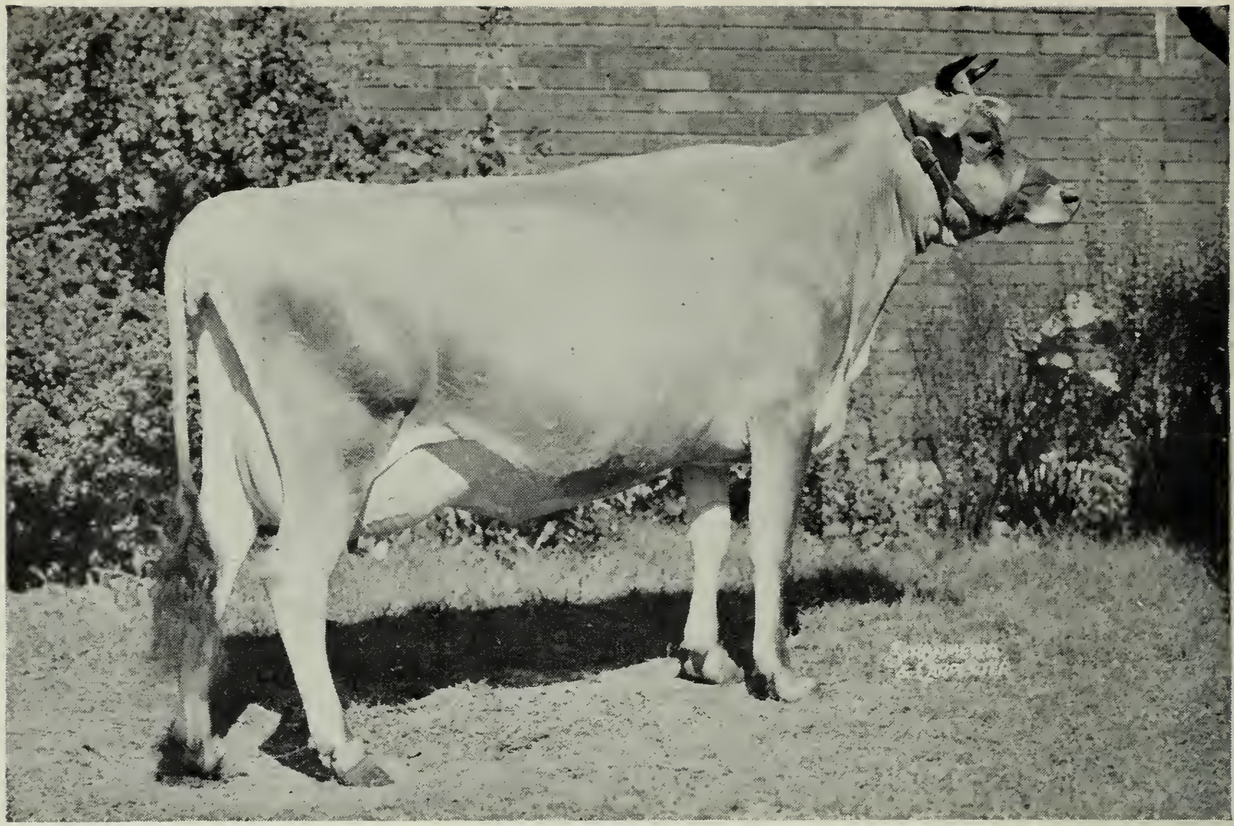
This mature cow shows strength, constitution, capacity, well developed mammary system, and throughout dairy quality, indicating producing ability. This picture was taken when the cow was eleven years old, and she therefore shows a maturity that is not shown in pictures of cows taken at an earlier age. Wearing qualities and longevity are desirable traits of any cow and are outstanding characteristics of this cow. Somewhat less throatiness, less hook on the hind legs, and a little smoother tail set would improve this cow.

It would appear that each breed has a definite place in the dairy programme of this Province. In the final analysis the beginner should choose the breed that appears best equipped to produce for the market selected. When in doubt choose the breed that is most common in the area, because such a decision is likely to result in increased opportunities for selling surplus stock.

The expression "Breed, Feed and Weed" is just as true today as when it was first uttered. As a consequence a dairyman should adopt a breeding program designed to improve the type and production of the natural increase in the herd. feed a ration that will stimulate the producing ability of the cows, and weed out those cows that do not measure up to profitable standards. Certain Policies sponsored by the Canada and the Ontario Department of Agriculture are proving helpful in achieving these objectives.

Record of Performance

The Record of Performance, or R.O.P. as it is commonly called, is sponsored by the Canada Department of Agriculture for the purpose of providing a milk testing service for pure bred cattle only. Breeders who participate are required to test all cows in the herd. Official tests are conducted at intervals of approximately one month. Daily weighing is optional with the breeder, but when it is not practiced a cow's production is computed on the basis of the official weight determined by the Inspector. Participants may milk twice, three



A JERSEY COW

This picture shows a Jersey cow with exceptional refinement and character in the head and a smoothly laid in shoulder with great width across the chest floor. Capacity is indicated by the good spring of rib and body depth. The udder carries up well in the rear and is well developed in the front quarters that are firmly attached. The hind quarter is very long, but might show more smoothness on top, particularly in front of the tail head.

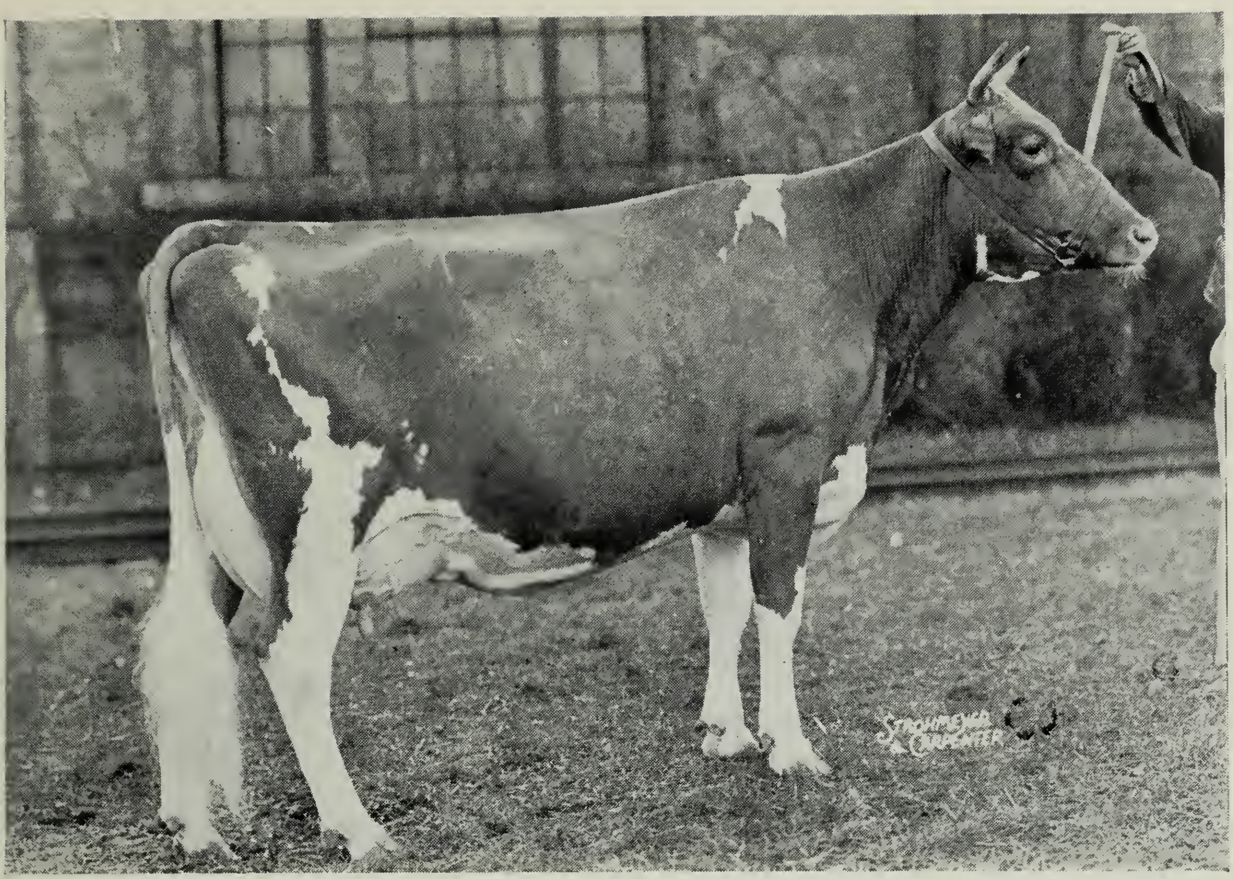
times, or four times daily, and may have their records based on 305 or 365-day lactations. Holstein breeders have limited the registration of bulls to those males that are out of cows with official records and that have certain other requirements. No dairyman should consider using a bull of any breed unless the bull is out of a record dam.

Dairy Herd Improvement Associations

This programme is sponsored by the Ontario Live Stock Branch for the purpose of providing a milk testing service to the owners of grade herds. A Supervisor is assigned to each Association consisting of 24 to 26 members. He calls on each member once per month, and officially weighs and tests milk produced by each cow. Records are computed on the basis of the information supplied by the supervisors and certificates of qualification are issued to the owners of cows producing butterfat in excess of specified amounts. All records are based on twice daily milkings, and a 305 day lactation period. All members are required to furnish data relative to cost of production, and receive reports covering this feature at the end of each testing year. A great many of the members also belong to artificial insemination units, and as a result of information supplied are in a position to make daughter-dam comparisons within their own herds.

Artificial Insemination

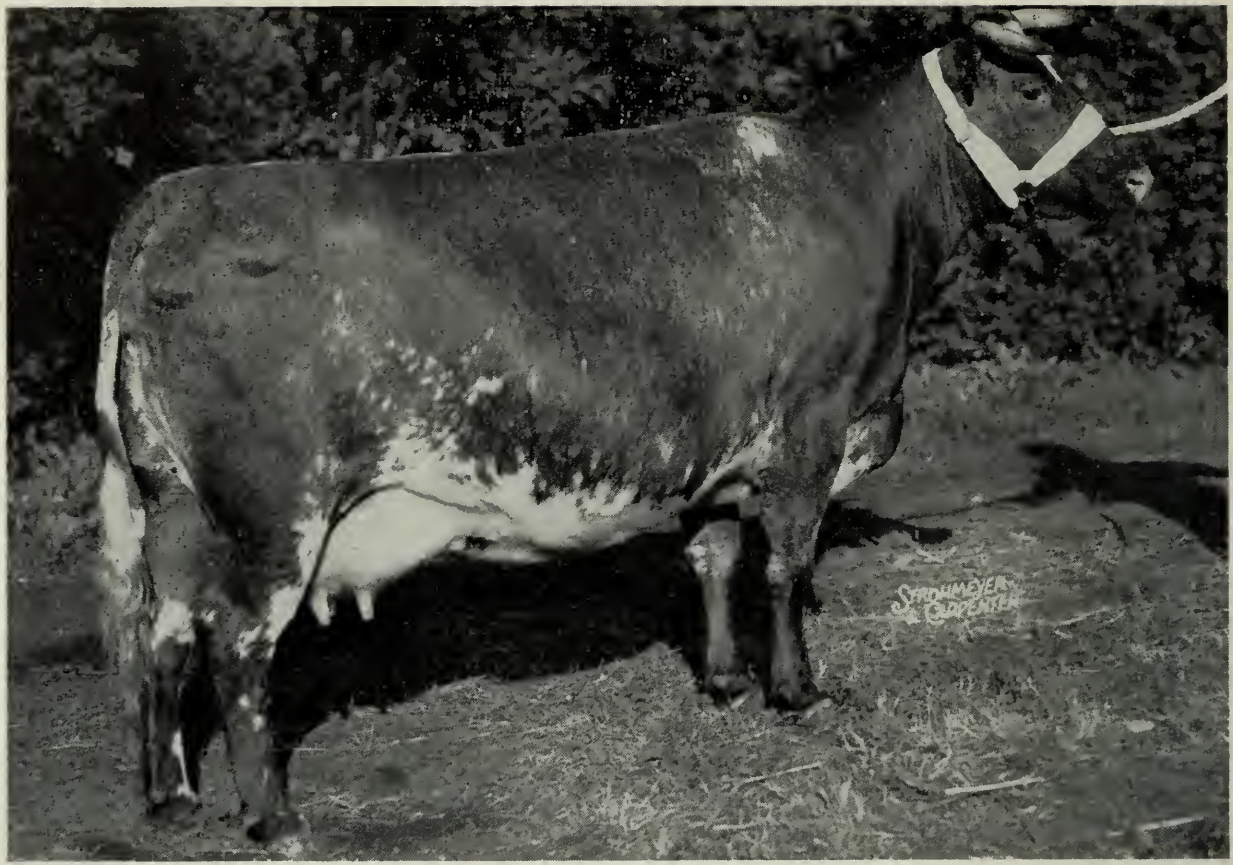
In 1947 the Legislature of Ontario enacted the “Artificial Insemination Act” for the purpose of controlling artificial insemination in the province. Seven centres have been licensed, with each providing service in several Counties



A GUERNSEY COW

A Guernsey cow showing the characteristics of this breed and outstanding dairy temperament wanted in a cow of any dairy breed. A former champion at major shows, she has a very smoothly laid in shoulder, a great constitution and body capacity. The quarter is well nigh perfect. It is long, wide at the pins, high in the thurl region, with no excess fattiness. The legs are of excellent quality and well shaped. The mammary system is almost beyond criticism, with a well attached, outstanding udder and body veins. There is no quartering and the teats are of correct shape and length, and throughout it shows quality and texture. Perfection is hard to attain and this cow might be criticized for a little plainness of head and flatness of loin.

surrounding its headquarters. It is now possible for every farmer in the province, except those who reside in isolated areas, to obtain service from a licensed Unit. While each centre does not attempt to maintain a battery of bulls of every dairy breed, a system of semen exchange between centres has been completed, whereby it is possible for most centres to provide service for all dairy breeds. These centres have been purchasing the best bulls available keeping in mind both production and type, and have not spared expense in their efforts to provide members with the best possible service. The Ontario Live Stock Branch grants financial assistance to licensed Units by paying a subsidy on buildings, sires, and cows serviced, thus making it possible for centres to provide service for a $5.00 fee. As a result the average dairyman can get his entire herd bred annually for less than the cost of maintaining a bull.



This picture shows a Dual Purpose Shorthorn combining beef type and milking qualities to a high degree. This cow is thickly fleshed and has size without coarseness. The udder shows quality with a nice blending into body. The teats are a convenient size and shape.

HERD FEEDING AND MANAGEMENT

The managerial ability of the dairyman may mean the difference between success or failure in the operation of a dairy farm. It involves the investment of capital, the management of labour and the soil, crops and the herd, the maintenance of herd health, the marketing problems of both milk and cattle and a flexibility of judgment to adjust the whole operation to the changing conditions of weather, season, markets and acts of nature.

One of the essential functions of dairying is to convert feeds, otherwise often unmarketable, into an edible marketable product. These feeds involve roughages and concentrates, home grown grains and purchased grains, by-products and mixed supplements and pasture of both permanent and temporary type. The preparation of suitable, economical rations becomes therefore one of the major activities of the dairyman.

NUTRIENT REQUIREMENTS OF DAIRY CATTLE

Feeds must supply energy, protein, fat and certain vitamins and minerals. The requirements of the herd for each item must be kept in mind in feeding dairy stock of different ages and at various levels of production.

Energy

Energy is required in large amounts for growth, lactation and reproduction, as well as the obvious requirements for physical activity and for keeping the body warm. In young animals insufficient energy supplies will result in poor and uneconomical weight gains. For satisfactory reproduction there must be adequate energy intake, and heavy lactation demands an even greater intake.

Energy is obtainable from carbohydrates, proteins and fats in feedstuffs, but the most plentiful and economical source of energy for cattle is the carbohydrate portion of the feed, including both the nitrogen-free extract (starches, sugars) and the fibre (cellulose) fractions. The action of the micro-organisms in the rumen enables cattle and other cud-chewing animals to digest much of the fibre consumed. The feeds high in fibre are known as "roughages", and this class includes pastures, hays and silages, as well as corn fodder. stover, corn cobs, and hulls of grains and other seeds. Feeds, such as grains, which are high in sugars and starches but low in fibre are known as energy "concentrates".

The term Total Digestible Nutrients (T.D.N.), used to express the energy value of a feed, includes all the digestible carbohydrates, protein and fat (the last being multiplied by 2¼ since it has a higher energy value than the others). The higher the T.D.N. value, the higher the energy content of a feed.

Proteins

Proteins are complex nutrients containing nitrogen in a special combination. They are absolutely essential to life in all animals, for the formation of muscles, organs, bones, milk and certain other body compounds. The requirement is greatest during periods of rapid growth, reproduction and lactation.

If the growing animal is not provided with enough protein to meet the heavy demands for new tissue, growth will be slowed down. Early and rapid gains are usually the most economical, and sufficient protein to permit this type of growth should be made available. It is well to bear in mind, however, that protein is usually the most expensive nutrient item, and the feeding of more than required is rarely economical. In pregnancy the cow requires additional protein to build the body of her calf, and in lactation the requirement is even greater to provide the large amount of protein in the milk.

Some animal species (e.g. poultry and swine) are very exacting in their requirement for specific "high quality" proteins. Fortunately, protein quality is not a problem with cattle. The bacteria in the rumen are able to manufacture good quality protein for the cow from poor quality protein in the feed, and, to some extent, from certain other nitrogen-containing substances which are not proteins. For example, the chemical substance urea can be used to replace a limited portion of the protein in cattle rations. Practically the only consideration in protein-carrying feeds for cattle is the digestibility of the protein contained, the proportion of the protein which is digestible varying from one feed to another.

Fat

Not all the fat in milk comes from fat in the feed, much of it being made from the carbohydrate portion. Nevertheless, the amount of fat in the ration does have an influence upon health and production. The concentrate portion of the ration should contain a minimum of 3.0 per cent fat. While not a common problem, excessive amounts of fat (over 6%) in the ration may cause digestive upsets and scouring.

Vitamins

Vitamins are a special class of nutrients required by animals in amounts which are very small in comparison with carbohydrates and proteins. Nevertheless, their presence in such amounts is essential for good health and production. The many vitamins required have individual functions to perform but, in general, they can be described as regulators of body processes.

Only two vitamins, A and D, require special attention in cattle feeding. The rumen bacteria manufacture vitamin K and all the vitamins of the B group, and thus an outside source of these is not required after the first two months of life. Prior to this, the calf obtains these vitamins from milk. There is no evidence that supplements of vitamin E are required by dairy cattle on usual rations.

Vitamin A

Vitamin A is obtained from the feed in the form of carotene, a yellow coloring material which the animal changes into colorless vitamin A within its body. Some of the vitamin A, the surplus over the cow's requirement for its own body activities, is stored in the liver and the body fat and secreted in the milk. Variable amounts of unchanged carotene also occur in these places, giving the yellow color to body fat and milk fat.

This vitamin is required for growth, for vision, for the maintenance of healthy conditions in the tissues of the digestive tract, the respiratory organs and the eyes, and for successful reproduction and lactation. Shortages of vitamin A will cause poor growth, and extreme deficiencies will lead to night blindness, sore eyes, staggering, poor muscular control, and reproductive troubles. More common than marked shortages are slight or borderline deficiencies causing lowered performance in growth, lactation and reproduction.

The common source of carotene for cattle is green plant material. It is found abundantly in fresh pasture, and the younger and leafier the growth, the higher the carotene content. Under similar conditions clovers and alfalfa are better sources than grasses.

Dried-up pasture-growth is very low in carotene and sun-cured hay contains less than the freshly cut crop since exposure of the drying plant material to sunshine and air readily destroys carotene. The newer methods for the barn-drying of hay usually yield hay much higher in carotene than field-curing, since long exposure to sunlight is avoided. A gradual destruction of carotene occurs in hay during storage in the mow. When carefully done, the making of silage from pasture and hay crops will preserve good amounts of the carotene in the crops. The green color of hays and silages can be used as a rough guide to their value as carotene sources, although the green color itself is not carotene. Carotene is found also in yellow corn, and the feeding of corn grain or corn and cob meal will, therefore, make a contribution to the vitamin A nutrition.

The ability of cattle to store some of the vitamin A surplus during periods of excess intake from excellent pasture is very valuable in assisting them through periods of low carotene intake, such as drought periods or late winter.

Supplementary vitamin A may be supplied to calves by dry or oily preparations. Fish liver oils, especially those of low potency, should not be used as supplements for milking cows.

Vitamin D

Growing animals require vitamin D for the formation of strong bones and teeth, and adult animals require it for maintaining these structures. The minerals calcium and phosphorus, which form the major portion of hard bone structure are not used and deposited properly in the absence of adequate vitamin D. A deficiency of vitamin D results in the condition of rickets in calves, the symptoms include swollen joints, lameness, and in later stages, decreased growth, dragging of hind feet and bending or even fractures in bones.

Vitamin D is obtained ordinarily by cattle in two ways: through exposure to sunlight which forms the vitamin in the body, and through the feed. Sun-cured plant material contains vitamin D produced through the action of the sun's rays. It should be noted that methods of hay-drying which avoid exposure to sunlight result in higher carotene retention, but, at the same time, prevent the formation of vitamin D in the hay. Similarly, forage preserved as silage contains little or no vitamin D.

Calves, especially those kept indoors, may require a vitamin D addition in the form of fish liver oil or a dry D supplement mixed with the concentrate.

Minerals

Of the numerous minerals known to be essential for dairy cattle many are present in the usual feeds in ample amounts, and usually only calcium, phosphorus, salt (sodium chloride), iodine and cobalt require special attention. The use of supplements to supply minerals other than these cannot be recommended at present for general use in Ontario despite the possibility that deficiencies in some other trace minerals may occur in certain regions which are not well defined as yet.

Calcium and Phosphorus

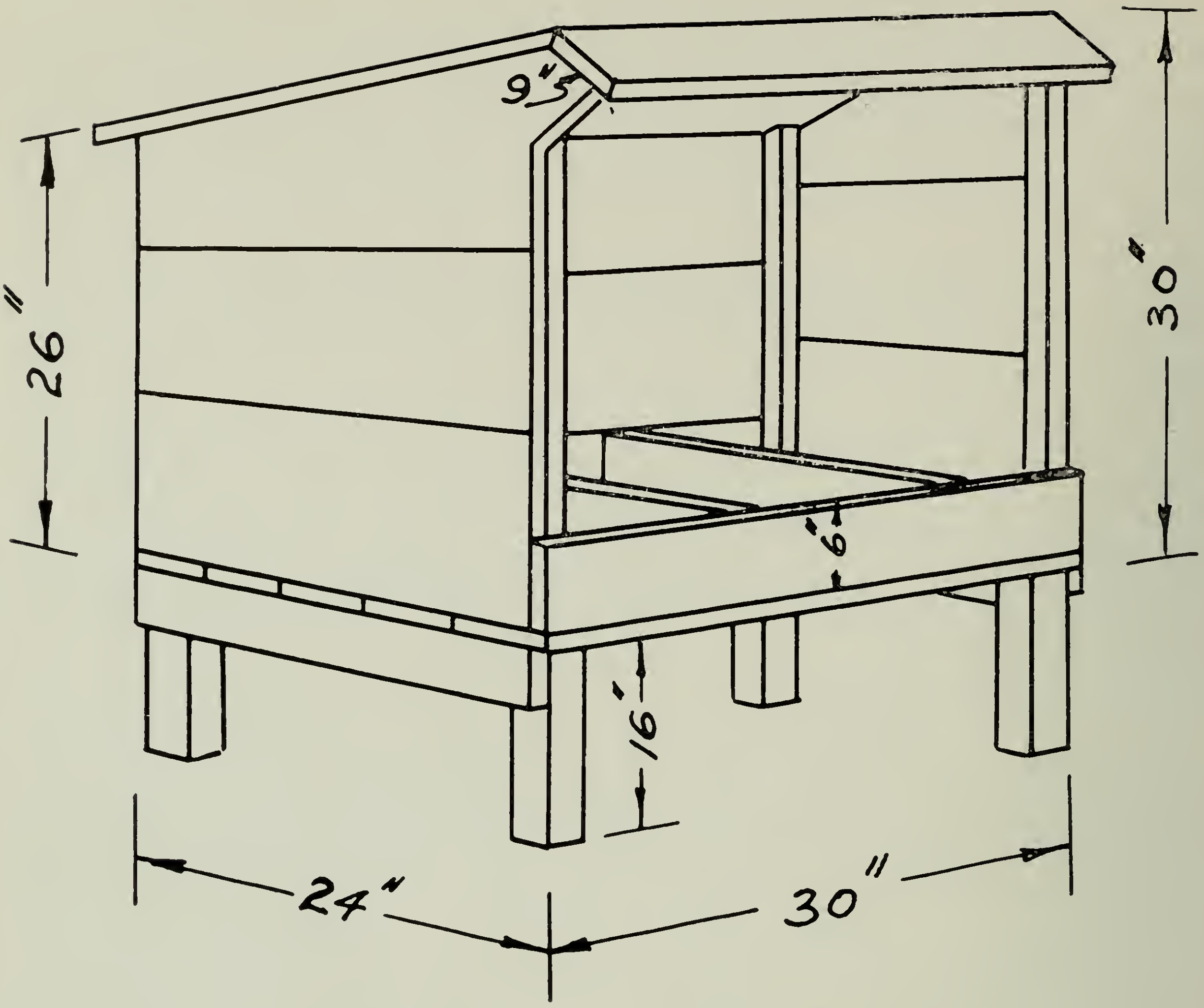
Calcium and phosphorus are discussed together since their utilization in the body is related, and in some of the supplementary sources they occur together. These two are the main mineral constituents of bones and teeth, and the demand for them is very great during growth and pregnancy to permit the manufacture of new bony structures. Since milk is very rich in both calcium and phosphorus, considerable additional supplies are required during lactation.

Insufficient supplies of either or both of these minerals will cause defects in bones resembling those described for vitamin D deficiency. Serious phosphorus shortages in rations give rise to some other symptoms such as a decrease in appetite, and as the deficiency progresses, a "depraved" appetite shown by a desire to chew bones, wood, dirt, etc.

Many Ontario soils are deficient in phosphorus, and feeds grown thereon are correspondingly low in this mineral. Cattle rations, therefore, most frequently show greater deficiency in phosphorus than in calcium. Forages are poor sources of phosphorus, grains and seeds are better. The latter are low in calcium, whereas forages are better but variable, legumes being much richer in calcium than are grasses. Young calves receive much calcium and phosphorus from milk.

Deficiencies of calcium and phosphorus are overcome by supplemental feeding of bone meal, dicalcium phosphate, monocalcium phosphate and *defluorinated* rock phosphates. Disodium phosphate supplies phosphorus only, whereas limestone provides calcium only. Various trade names are applied to these products by manufacturers. The amounts and proportions of the supplements to be fed depend somewhat upon the other ration ingredients, especially the nature of the roughage. The best procedure is to blend the supplements with salt and to mix a definite proportion with the home-mixed concentrate and in addition to allow the animals free access to the mineral mixture in a separate covered box.

Most commercial mixed concentrates contain supplementary minerals and it is not necessary to mix in any additional mineral. When feeding these concentrates, however, it is still wise to allow the animals free access to a mineral mixture.



A simply constructed weather protected salt and mineral box.

Salt, Iodine, Cobalt

Common salt (sodium chloride) serves many functions. It aids in milk production and serves to improve the palatability of the ration and to stimulate the appetite.

Iodine, although required in very small amounts, is a very vital mineral, essential for the activity of the thyroid gland which is the master control for all body processes. Deficiency of iodine is indicated when calves are born with goitre or "thick neck". A supplement is recommended for Ontario feeding conditions, and the most convenient and satisfactory supplement is iodized salt.

Within recent years it has been found that crops in some areas of Ontario are low in the mineral cobalt, and cattle feeding on them may not receive enough of this mineral unless a supplement is fed. A deficiency leads to unthrifty, listless animals which show gradual loss of appetite, weight loss, rough coats and anaemia. A depraved appetite similar to that of phosphorus deficiency may develop, and reproductive troubles may be encountered.

The small amount of supplementary cobalt required can be supplied best in the form of cobaltized salt. Its use is recommended for all Ontario dairy cattle.

The iodized and cobaltized salt may be mixed with concentrates or placed in a covered box in the yard or pasture field with the other minerals.

Mineral Supplements and Mixtures

Various combinations of the suggested calcium and phosphorus supplements and salt may be used to meet particular needs. Some suggested mixtures are given below:

A. 50 pounds steamed Bone Meal, 25 pounds Disodium phosphate, 25 pounds Iodized Cobaltized Salt.

B. 50 pounds Feeding Bone Meal, 25 pounds Monocalcium Phosphate, 25 pounds Iodized Cobaltized Salt.

C. 50 pounds *Defluorinated* Rock Phosphate, 25 pounds Disodium Phosphate, 25 pounds Iodized Cobaltized Salt.

D. 50 pounds Monocalcium Phosphate, 17 pounds Ground Limestone, 33 pounds Iodized Cobaltized Salt.

E. 67 pounds Feeding Bone Meal, 33 pounds Iodized Cobaltized Salt.

It should be borne in mind that the color of salt blocks containing iodine (red-brown) and cobalt (blue or purple) is due to added coloring substances and not to the trace minerals themselves. The fact that iodized and cobaltized loose salt may not be colored does not make it inferior nutritionally.

Various other combinations of available supplements may be used with satisfactory results. In table number 2 are given average figures for the calcium and phosphorus contents of the common supplements and for the mixtures suggested above.

TABLE No. 2.

	Calcium		**Phosphorus**	
	%	**Grams per lb.**	%	**Grams per lb.**
Supplements				
Bone Meal (Feeding)	25.0	113.5	10.9	49.5
Bone Meal (Steamed)	29.1	132.1	14.3	64.9
Dicalcium Phosphate	26.5	120.3	20.5	93.1
Disodium Phosphate	—	—	8.6	39.0
Limestone (Calcite)	38.3	173.9	—	—
Monocalcium Phosphate	16.0	72.6	24.0	109.0
Phosphate with Colloidal Clay	20.0	90.8	10.0	45.4
Rock Phosphate (*Defluorinated*)	27.0	122.6	13.4	60.8
Mixtures				
A	14.6	66.4	9.3	42.2
B	16.5	75.0	11.45	52.0
C	13.5	61.3	8.9	40.4
D	14.5	65.9	12.0	54.6
E	16.8	76.3	7.3	33.2

Feeding Standards

Studies of cattle feeding by many investigators in many locations have made it possible to recommend actual amounts of the individual nutrients which should be provided for animals of various sizes and ages and at different stages of production. All animals do not have exactly the same requirements even under similar circumstances, and usually the amounts recommended are near the maximum requirement. Recommendations have been presented in different forms by different investigators and groups, usually under the names of "Feeding Standards" or "Recommended Allowances".

TABLE No. 3. MORRISON FEEDING STANDARDS.

	Digestible protein (Lower amounts, minimum advised. Higher amounts, advised under usual conditions.)	Total digestible nutrients (Lower amounts, minimum advised. Higher amounts, advised under usual conditions.)	Calcium		Phosphorus		Carotene
			Grams	Lb.	Grams	Lb.	Mg.
1. Dairy cows							
A. For maintenance, per head daily							
800 lb. cow	.49- .54	5.8- 6.5	8.0	.018	8.0	.018	48
900 lb. cow	.55- .59	6.4- 7.2	9.0	.020	9.0	.020	54
1000 lb. cow	.60- .65	7.0- 7.9	10.0	.022	10.0	.022	60
1100 lb. cow	.65- .71	7.6- 8.6	11.0	.024	11.0	.024	66
1200 lb. cow	.70- .76	8.2- 9.3	12.0	.026	12.0	.026	72
1300 lb. cow	.75- .82	8.8-10.0	13.0	.029	13.0	.029	78
1400 lb. cow	.80- .87	9.4-10.6	14.0	.031	14.0	.031	84
1500 lb. cow	.85- .92	10.0-11.3	15.0	.033	15.0	.033	90
1600 lb. cow	.90- .98	10.5-11.9	16.0	.035	16.0	.035	96
1700 lb. cow	.95-1.03	11.1-12.6	17.0	.037	17.0	.037	102
1800 lb. cow	1.00-1.08	11.7-13.2	18.0	.040	18.0	.040	108
B. For milk production per pound of milk (To be added to allowance for maintenance)							
For 3.0% milk ..	.036-.043	.26-.28	1.0	.0022	.75	.0017	......
For 3.5% milk ..	.038-.046	.28-.30	1.0	.0022	.75	.0017	......
For 4.0% milk ..	.041-.049	.31-.32	1.0	.0022	.75	.0017	......
For 4.5% milk ..	.044-.052	.33-.35	1.0	.0022	.75	.0017	......
For 5.0% milk ..	.046-.056	.35-.37	1.0	.0022	.75	.0017	......
For 5.5% milk ..	.049-.059	.38-.40	1.0	.0022	.75	.0017	......
For 6.0% milk ..	.052-.062	.40-.42	1.0	.0022	.75	.0017	......
For 6.5% milk ..	.054-.065	.42-.45	1.0	.0022	.75	.0017	......
C. Additional allowance for last 2 to 3 months of pregnancy (To be added to allowances for maintenance and allow for milk produced)							
Small cow	.50-.55	5.0-5.5	10.4	.023	6.4	.014	24
1000 lb. cow	.55-.60	5.5-6.0	13.0	.029	8.0	.018	30
Large cow	.65-.70	6.5-7.0	15.6	.034	9.6	.021	36

TABLE No. 4. MORRISON FEEDING STANDARDS.

	Requirements Per Head Daily							
	Dry matter	Digestible protein	Total digestible nutrients	Calcium		Phosphorus		Carotene
	Lbs.	Lbs.	Lbs.	Grams	Lb.	Grams	Lb.	Mg.
2. Growing dairy cattle								
Weight 100 lbs.	1.6- 2.6	.30- .40	1.4- 2.1	8	.018	6	.013	6
Weight 200 lbs.	4.7- 6.4	.53- .62	3.5- 4.5	16	.035	11	.024	12
Weight 300 lbs.	7.2- 9.0	.67- .77	5.0- 6.0	18	.040	13	.029	18
Weight 400 lbs.	9.1-11.4	.76- .87	6.0- 7.0	20	.044	15	.033	24
Weight 500 lbs.	10.7-13.0	.81- .92	6.9- 8.1	19	.042	15	.033	30
Weight 600 lbs.	12.4-14.7	.84- .95	7.9- 9.1	18	.040	15	.033	36
Weight 700 lbs.	14.2-16.5	.87- .98	8.6- 9.9	17	.037	15	.033	42
Weight 800 lbs.	15.9-18.3	.90-1.00	9.2-10.6	16	.035	15	.033	48
Weight 900 lbs.	17.3-19.7	.93-1.03	9.8-11.2	16	.035	15	.033	54
Weight 1000 lbs.	18.6-21.0	.95-1.05	10.3-11.7	15	.033	15	.033	60

CHARACTERISTICS OF FEEDS

GRAINS, BY-PRODUCTS AND CONCENTRATES

Barley

Barley is higher in digestible nutrients than oats, coming close to corn in this respect. It is essentially an energy or fattening feed. Although ground barley makes a heavy meal it may constitute one-third of the concentrate if it is mixed with oats, bran or bulky protein concentrates.

Beet Pulp, Dried

Dried beet pulp, a by-product of sugar refineries, is often fed as a substitute for silage or roots. It is a bulky feed, laxative, and low in protein. If heavily fed it should be moistened with three times its weight of water before feeding and molasses may be added to take the place of part of the sugar taken out of the beets and to improve the palatability. Soaking is not essential if feeding only a few pounds per day.

Brewers' Grains, Dried

The residue from barley used in the production of malt liquors is known as Dried Brewers' Grains. The carbohydrate content is low and both the protein content and fibre content are quite high. The T.D.N. value will approach that of wheat bran. The high fibre content makes this a bulky feed valuable for use with heavy meals.

Corn

Although the lowest of the grains in protein content, corn is highest in carbohydrates and total digestible nutrients. It is a palatable, readily utilized feed, but should not form more than half the dairy cow's meal ration, being fed in the ground form along with protein concentrates of a bulky nature. Yellow corn is the only grain that supplies appreciable amounts of carotene to the ration.

Corn and Cob Meal

In corn-growing areas the whole ears of corn, including the cobs, may be ground for cattle feed. This mixture contains less protein, considerably more fibre, and 10 to 15% less T.D.N. than corn grain, and is bulkier.

Corn Gluten Feed

This product, sometimes known simply as gluten feed, is a by-product from the manufacture of corn starch, and is quite high in protein, containing about two-thirds the amount in linseed oil meal or cottonseed meal. Since much of the corn bran is contained in this product it has a moderate fibre content, but it is almost as high as corn in total digestible nutrients.

Cottonseed Meal

One of the richest protein sources for dairy cattle is cottonseed meal, the residue from the production of cottonseed oil. It is constipating and is not recommended at freshening time, nor is it too satisfactory for young stock, its use being confined largely to regular production rations.

Hominy Feed

This by-product from the manufacture of hominy flour or grits from corn is similar to corn in over-all feeding value and can be used in the same way as corn.

Linseed Oil Meal

The residue from the production of linseed oil from flaxseed is known as "oil cake" or "oil cake meal" as well as "linseed oil meal". It is high in protein and is used to increase the protein content of meal mixtures. It is highly favoured for test cows and for use at freshening time. The "old process" meal is the more common and contains more fat and T.D.N. than the "solvent process meal".

Oats

The most extensively grown cereal crop in Ontario is oats. The oat grain contains more protein than corn, about the same as wheat or barley and less carbohydrate than corn, barley or wheat. Oats form the basis for most of the concentrate mixtures fed to producing cows in Ontario with the appropriate addition of high-protein supplements and other grains. Ground oats make a desirable bulky meal, and when rolled the bulkiness is greater. The fibrous hulls are low in feeding value.

Soybean Oil Meal

Another high-protein supplement is soybean oil meal, a by-product from the production of soybean oil. Its protein content is generally higher than that of linseed oil meal. The solvent process meal is becoming more common and the fat content and T.D.N. value are below those for the expeller process meal. The protein content is a little higher. This palatable supplement is used in the same way as linseed oil meal or cottonseed meal.

Soybeans

Whole soybeans are frequently used as a protein concentrate, but cannot be used in as great amounts as oil cake because of lower palatability. Soybeans are high in fat and therefore somewhat lower in protein than soybean oil meal.

Wheat

Wheat is rich in carbohydrates and approaches corn in total digestible nutrients. In the ration it can be used in the same way as barley, or may replace part of the oats or the bran. When ground, wheat tends to make a heavy pasty meal. Soft winter wheats can be rolled to overcome this difficulty.

Wheat Bran

Bran is a milling by-product of wheat, and is widely used in dairy rations. It is higher in protein, minerals (especially phosphorus) and fibre than whole wheat, but lower in total digestible nutrients. It is palatable, laxative, and because of its bulk it is useful for mixing with heavier grains.

Wheat Shorts

A somewhat heavier by-product than bran, shorts are higher in T.D.N., lower in fibre, and similar or slightly higher in protein. Their use in cattle rations is limited somewhat by their slightly sticky texture.

ROUGHAGES

Alfalfa

Alfalfa is one of the best roughage feeds, and while it may have limitations as a pasture crop it makes splendid hay. It is richer in protein than red clover hay but contains less fat and carbohydrates. Alfalfa, if cut just when the new shoots are starting at the base of the old plants, yields the maximum amount of feed with a large percentage of leaf. By feeding good alfalfa hay liberally the dairyman is able to reduce both the amount and the protein strength of the meal ration. It makes an excellent feed for young and growing stock as well as for milk cows. Green alfalfa makes a valuable feed for soiling purposes as it grows rapidly in the spring and comes up quickly after cutting.

Brome Grass

Brome grass is a very common component of mixtures used as combination pasture and hay crops. It is a heavy yielder and has the typical composition characteristics of the grasses.

Red Clover

Red Clover is good legume roughage for all classes of dairy stock when used as a hay, pasture or soiling crop. It does not yield as much per acre as alfalfa but works well into short crop rotations and stands pasturing better. To make the best quality hay it should be cut soon after it is in full bloom and cured to preserve as much leaf as possible. In feeding value it resembles alfalfa.

Sweet Clover

Sweet clover gives best results as a pasture crop, a silage crop and as a soil builder. When used for pasture it should be grazed early in the season to prevent the crop becoming coarse, bitter and unpalatable. It gives best results as pasture when used along with some other crop. It is not held in high favour as a hay crop. Spoiled or mouldy sweet clover should never be fed. Cattle should not be dehorned when being fed on sweet clover.

Corn Fodder

By corn fodder is meant the corn plant with the ear attached. It is a valuable roughage because of the amount that can be grown per acre. It is low in protein but fairly rich in carbohydrates. Cut green in the late summer and early fall it is valuable as a soiling crop. When dried it is used for fall and early winter feeding. Later it becomes dry and woody and should be run through the cutting box to get best results. Corn for this purpose should be thickly sown to get a high percentage of leaf and stem.

Corn Silage

Corn silage is one of the best roughages of silage type for dairy cattle. There is little wastage and, instead of a dry forage, silage supplies a large bulk of succulent feed which is particularly valuable during the winter. Corn for the best quality silage, should be put in the silo when in the dented stage. Silage is also useful for feeding in the summer months when pasture is scarce. In the winter feeding of dairy cattle, silage should be supplemented with a protein-rich feed.

Corn Stover

Corn stover is the corn stalk after the ear has been removed. The crop is more matured than in the case of corn fodder and this detracts from its feeding value. It is of more value than straw and should be run through the cutting box before feeding.

Grass Silage

The name grass silage is given to silage made from any of the common grasses, legumes or mixtures ordinarily used for pasture and hay. The name "hay crop silage" is sometimes used. The composition of the mixture used to fill the silo will influence the feeding-value of the silage produced, the protein and mineral content increasing with the proportion of alfalfa or other legumes in the mixture. The protein content will generally be better than that of corn silage, but the total digestible nutrients frequently will be lower. Grass silage may be somewhat less palatable than corn silage. The making of grass silage, especially with high proportions of legumes, is more difficult than the making of corn silage. O.A.C. Bulletin No. A102 on "Grass Silage" gives details on making and using grass silage.

Orchard Grass

Orchard grass is grown to a slight extent in Ontario. It is coarser, less palatable and, as a hay crop, is harder to cure than timothy. As a pasture crop it withstands the hot weather well and grows satisfactorily in the shade. It is satisfactory to mix with grasses and clovers in a permanent pasture mixture. Proper management of orchard grass is important to prevent coarse woody herbage.

Roots

Roots are of value as a feed for dairy cattle in that they are palatable, succulent, laxative and easily digested. For all ages of dairy cattle roots form an excellent feed, particularly for young calves just commencing to eat and for test cows where high milk records are desired. Corn silage has very largely replaced the roots, as it furnishes the succulent feed necessary for winter feeding at a lower labor cost.

Straw

All classes of straws are high in fibre and consequently are of little value as a feed for dairy cows. When fed, more concentrates are necessary to properly balance the ration. For dry cows straw may be used as a part of the roughage. Taking everything into consideration, oat straw is the best, barley straw next, with wheat and rye straw lower in feeding value. Buckwheat straw contains a little more protein but is so high in fibre that it is unsatisfactory as a feed. The straw from legumes such as peas and beans has a higher feeding value than that from the cereals.

Timothy

While timothy hay is the standard and most satisfactory roughage for horses, it is not so for dairy cattle. It is lower in protein than clover hay and is usually not as palatable. If it is to be used for dairy cattle it is best cut when quite young. Milk cows require more concentrates with timothy than they do with the legume hays.

COMPOSITION OF FEEDS

Different lots of feeding stuffs may vary considerably in chemical composition as the result of variations in many factors including season, soil, processing, and maturity. Nevertheless, under practical circumstances, analysis of all feeds used is out of the question, and use must be made of average figures for feed analyses based on numerous determinations. Such average values are very useful in planning rations to meet recommended allowances.

In Table No. 6 are listed average composition figures for some of the feeding stuffs in common use for dairy cattle. These figures are taken from F. B. Morrison's "Feeds and Feeding" (21st edition). It should be emphasized that this table gives the average analyses for the products as fed, and not on a dry-matter basis, as is sometimes done.

A knowledge of the composition of feeds is the basis for the successful formulae mixing.

TABLE No. 5.

COST OF ONE POUND OF TOTAL PROTEIN IN COMMON CONCENTRATE FEEDS

Feed	% of Total Protein	Pounds of Total Protein per Ton	Cost per Pound of Total Protein in Cents, When the Cost per Ton is:									
			$50	$55	$60	$65	$70	$75	$80	$85	$90	$100
Oats	12.4	248	20.2	22.2	24.2	26.2	28.2	30.2	32.2	34.3	36.4	40.4
Barley	11.5	230	21.7	23.9	26.0	28.2	30.4	32.6	34.8	37.0	39.2	43.4
Wheat	12.4	248	20.2	22.2	24.2	26.2	28.2	30.2	32.2	34.2	36.2	40.4
Corn	10.1	202	24.6	27.1	29.6	32.1	34.6	37.1	39.6	42.0	44.4	49.2
Brewers' Grains (dried)	25.6	512	9.8	10.7	11.7	12.7	13.6	14.6	15.6	16.6	17.6	19.6
Linseed Oil Meal (old process)	33.9	678	7.4	8.1	8.8	9.6	10.4	11.1	11.8	12.5	13.2	14.8
Soybean Oil Meal	44.0	880	5.7	6.2	6.9	7.4	8.0	8.5	9.0	9.6	10.2	11.4
Gluten Feed	25.4	508	9.8	10.8	11.8	12.8	13.8	14.8	15.8	16.7	17.6	19.6
Wheat Bran	16.0	320	15.6	17.2	18.8	20.3	21.8	23.4	25.0	26.5	28.1	31.2
24% Dairy Concentrate	24.0	480	10.4	11.4	12.4	13.5	14.6	15.6	16.6	17.7	18.8	20.8
32% Dairy Concentrate	32.0	640	7.8	8.6	9.4	10.2	11.0	11.7	12.4	13.2	14.0	15.6

Table No. 6. Average Composition of Feeding Stuffs as Fed

Feeding Stuff	Dry Matter %	T.D.N. %	Digestible Protein %	Crude Protein %	Fat %	Fibre %	NFE %	—Calcium—		—Phosphorus—	
								%	grams per lb.	%	grams per lb.
Pastures and Green Fields											
Alfalfa	25.3	14.7	3.4	4.5	0.9	7.2	10.4	0.35	1.59	0.07	0.32
Alfalfa and Brome Grass (Half Alfalfa)	22.4	14.6	3.6	4.6	0.8	5.2	9.4	0.3	1.36	0.07	0.32
Alfalfa and Timothy (Half Alfalfa)	21.7	14.1	3.4	4.3	0.8	4.5	9.7	0.3	1.36	0.07	0.32
Blue Grass, Kentucky	30.2	19.2	3.9	5.5	1.2	7.6	13.4	0.16	0.73	0.13	0.59
Clover, Ladino	16.3	11.4	3.7	4.4	0.4	2.2	7.1	0.2	0.91	0.07	0.32
Clover, Red, before bloom	18.7	13.3	3.2	4.3	0.6	2.6	9.2	0.36	1.63	0.06	0.27
Clover and Mixed Grasses	20.0	13.9	3.4	4.5	0.8	3.6	9.6	0.23	1.04	0.07	0.32
Clover, Sweet, before bloom	20.8	12.8	3.2	4.1	0.7	4.9	9.2	0.34	1.54	0.10	0.45
Corn Fodder, Dent, Tassel Stage	15.0	9.7	1.0	1.6	0.3	4.2	7.8	0.06	0.27	0.05	0.23
Grasses, Mixed, Young	29.7	20.5	3.8	5.1	1.5	6.3	13.8	0.15	0.68	0.09	0.41
Kale	11.8	8.0	1.9	2.4	0.5	1.6	5.5	0.19	0.86	0.06	0.27
Millet	24.7	15.6	1.2	2.0	0.6	7.4	12.9	0.10	0.45	0.06	0.27
Oat Pasture	14.0	9.1	2.4	3.2	0.6	2.8	5.4	0.06	0.27	0.09	0.41
Oats and Peas	22.5	14.3	2.4	3.2	0.9	6.3	10.2	0.17	0.77	0.07	0.32
Rye Pasture	19.7	13.2	4.0	5.4	0.9	3.5	7.4	0.13	0.59	0.10	0.45
Sudan Grass	21.6	14.3	2.4	3.3	0.6	5.6	10.2	0.12	0.54	0.10	0.45
Timothy	23.9	15.4	3.5	4.7	0.9	4.6	11.1	0.14	0.64	0.09	0.41
Silages											
Alfalfa, wilted, no preservative	36.0	21.3	4.1	6.0	1.4	11.7	13.7	0.51	2.32	0.12	0.54
Clover (Ladino) and Timothy	29.7	17.9	3.8	6.0	1.6	6.9	12.3	0.36	1.63	0.06	0.27
Clover, Red	30.9	18.3	2.6	4.0	0.9	10.2	13.4	0.50	2.27	0.07	0.32
Clover and Mixed Grasses	36.0	22.7	2.6	4.4	1.1	11.0	16.4	0.29	1.32	0.12	0.54
Corn, Dent, Well-matured	27.4	18.1	1.2	2.2	0.8	6.7	16.1	0.10	0.45	0.06	0.27
Grass Silage, considerable legumes	33.3	19.1	2.9	5.2	1.3	8.7	14.2	0.25	1.14	0.12	0.54
Timothy, not wilted, grain added	33.1	19.2	2.3	4.0	1.1	10.4	15.6	0.19	0.86	0.11	0.50
Roots											
Mangels	9.2	7.0	0.9	1.3	0.1	0.8	6.0	0.01	0.05	0.03	0.14
Sugar Beets	16.4	13.7	1.2	1.6	0.1	1.0	12.6	0.04	0.18	0.04	0.18

AVERAGE COMPOSITION OF FEEDING STUFFS AS FED (Continued)

Feeding Stuff	Dry Matter %	T.D.N. %	Digestible Protein %	Crude Protein %	Fat %	Fibre %	NFE %	Calcium %	Calcium grams per lb.	Phosphorus %	Phosphorus grams per lb.
Hays, Other Dried Roughages											
Alfalfa	90.5	50.3	10.5	14.8	2.0	28.9	36.6	1.47	6.67	0.24	1.09
Alfalfa Meal (Dehydrated)	93.6	54.7	13.8	18.9	2.8	24.3	38.1	1.50	6.81	0.35	1.59
Alfalfa and Brome Grass	89.3	46.8	7.2	12.4	2.0	28.6	38.1	0.74	3.36	0.24	1.09
Alfalfa and Timothy	89.8	49.1	6.6	11.1	2.2	29.5	40.3	0.81	3.68	0.21	0.95
Clover, Ladino	88.0	54.9	14.2	19.4	3.2	20.7	34.9	1.32	5.99	0.29	1.32
Clover, Red	88.1	52.2	7.1	11.8	2.6	27.2	40.1	1.35	6.13	0.19	0.86
Clover and Timothy	88.1	51.2	4.8	8.6	2.2	30.3	41.2	0.68	3.09	0.20	0.91
Corn Fodder	91.1	58.8	3.8	7.8	2.2	27.1	47.6	0.24	1.09	0.16	0.73
Corn Stover (ears removed)	90.6	51.9	2.1	5.9	1.6	30.8	46.5	0.29	1.32	0.05	0.23
Millet	90.3	50.7	5.6	9.3	2.2	23.9	47.6	0.29	1.32	0.16	0.73
Mixed Grass Hay	89.0	51.7	3.5	7.0	2.5	30.9	43.1	0.48	2.18	0.21	0.95
Straw, Oat	89.7	44.7	0.7	4.1	2.2	36.1	41.0	0.19	0.86	0.10	0.45
Straw, Wheat	92.5	40.6	0.3	3.9	1.5	36.9	41.9	0.21	0.95	0.07	0.32
Timothy	89.0	48.9	2.9	6.5	2.4	30.2	45.0	0.23	1.04	0.20	0.91
Grains, Seeds, By-Product Concentrates											
Barley	89.4	77.7	10.0	12.7	1.9	5.4	66.6	0.06	0.27	0.37	1.68
Beet Pulp (dried)	90.1	67.8	4.3	9.2	0.5	19.8	57.2	0.67	3.04	0.08	0.36
Brewers' Grains (dried)	92.3	61.8	16.8	23.4	6.4	16.1	42.5	0.19	0.86	0.33	1.50
Corn, Yellow	87.0	82.0	6.8	8.8	4.0	2.1	70.9	0.02	0.09	0.28	1.27
Corn and Cob Meal	86.1	73.2	5.3	7.3	3.2	8.0	66.3	—	—	0.22	1.00
Corn Gluten Feed	90.9	76.0	21.9	25.5	2.7	7.6	48.8	0.48	2.18	0.82	3.72
Cottonseed Meal	92.8	70.6	32.8	41.5	6.3	10.4	28.1	0.20	0.91	1.22	5.54
Hominy Feed	90.4	84.5	8.0	11.2	6.9	5.2	64.2	0.02	0.09	0.50	2.27
Linseed Oil Meal (old process)	91.0	77.2	30.8	35.4	5.8	8.2	36.0	0.39	1.77	0.87	3.95
Linseed Oil Meal (Solvent process)	90.4	72.3	31.0	36.9	2.9	8.7	36.3	—	—	—	—
Milk, skim, dried	94.2	80.7	31.2	34.7	1.2	0.2	50.3	1.30	5.90	1.03	4.68
Oats	90.2	70.1	9.4	12.0	4.6	11.0	58.6	0.09	0.41	0.34	1.54
Oats, Light weight	91.3	60.1	8.5	12.3	4.7	15.4	54.4	—	—	—	—
Soybean Oil Meal (Expeller)	90.9	78.4	37.2	44.3	5.3	5.7	29.6	0.29	1.32	0.66	3.00
Soybean Oil Meal (Solvent process)	90.6	78.5	42.4	46.1	1.0	5.9	31.8	0.30	1.36	0.66	3.00
Soybeans	90.0	87.6	33.7	37.9	18.0	5.0	24.5	0.25	1.14	0.59	2.68
Wheat	89.5	80.0	11.1	13.2	1.9	2.6	69.9	0.04	0.18	0.39	1.77
Wheat Bran	90.1	67.2	13.7	16.9	4.6	9.6	52.9	0.14	0.64	1.29	5.86
Wheat Shorts	88.9	77.4	15.0	17.9	4.2	5.7	56.9	0.13	0.59	0.84	3.81

RULES FOR FEEDING DAIRY COWS

Based on the requirements as stated in the feeding standards simple thumb rules have been devised for calculating rations. In applying these rules their limitations must be appreciated. They are not intended to take the place of individual attention as they may provide too much feed for cows that are nearly dry and indicate inadequate amounts for heavy yielders and immature milkers. Despite shortcomings these feeding rules have a place in formulating the basic rations for the herd.

ROUGHAGE FEEDING:—

1½ lbs. hay and 3 lbs. silage per 100 lbs. live weight
or
1½ lbs. hay 2 lbs. roots and 2 lbs. silage per 100 lbs. live weight
or
1½ lbs. hay and 4 lbs. roots per 100 lbs. live weight
or
2 to 2½ lbs. hay per 100 lbs live weight.

GRAIN FEEDING:—

1. Feed daily 1 pound of meal mixture for every 3 to 5 pounds of milk produced.
2. When feeding alfalfa or clover hay, with or without silage or roots, use a meal mixture containing 15 to 17 per cent total protein.
3. When feeding timothy or grass hay, with or without silage or roots, use a meal mixture containing 17 to 19 per cent total protein.

SUGGESTED MEAL MIXTURES FOR DAIRY COWS IN MILK:—

(a) Examples of meal mixtures containing 15 to 17 per cent total protein suitable for feeding with good alfalfa or red clover hay, with or without silage.

1.	Oats	500 lbs.
	Barley	200 lbs.
	Corn Gluten Feed	100 lbs.
	Wheat Bran	100 lbs.
	Linseed Oil Meal	100 lbs.
2.	Oats	450 lbs.
	Corn and Cob Meal	200 lbs.
	Wheat Bran	100 lbs.
	Dried Brewers' Grains	100 lbs.
	Soybeans	150 lbs.
3.	Oats	500 lbs.
	Barley	200 lbs.
	Wheat	150 lbs.
	Linseed Oil Meal	150 lbs.
4.	Oats	500 lbs.
	Barley	200 lbs.
	Wheat Bran	200 lbs.
	Soybean Oil Meal	100 lbs.
5.	Mixed Grain	700 lbs.
	Commercial Dairy Concentrate (24%)	300 lbs.
6.	Mixed Grain	800 lbs.
	Commercial Dairy Concentrate (32%)	200 lbs.

SUGGESTED MEAL:—

Examples of meal mixtures containing from 17% to 19%. To be fed with mixed hay (chiefly grasses) or timothy hay, with or without silage or roots.

1.	Oats	400 lbs.
	Barley	100 lbs.
	Wheat Bran	200 lbs.
	Linseed Oil Meal	100 lbs.
	Cottonseed Meal	100 lbs.
2.	Oats	300 lbs.
	Wheat	100 lbs.
	Corn	100 lbs.
	Wheat Bran	200 lbs.
	Cottonseed Meal	100 lbs.
	Linseed Oil Meal	100 lbs.
3.	Oats	400 lbs.
	Barley	100 lbs.
	Wheat	100 lbs.
	Soybeans	200 lbs.
	Linseed Oil Meal	100 lbs.
4.	Oats	400 lbs.
	Barley	100 lbs.
	Wheat	150 lbs.
	Linseed Oil Meal	250 lbs.
5.	Mixed Grain	500 lbs.
	Commercial Dairy Concentrate (24%)	500 lbs.
6.	Mixed Grain	800 lbs.
	Commercial Dairy Concentrate (32%)	300 lbs.

Considerable variation exists in the kinds and amounts of grains and protein supplements available for the making of grain mixtures. To facilitate the formation of these from a wide variety of ingredients "pattern" formulae as outlined are useful:

15-17% TOTAL PROTEIN:—

(a) To be fed with good alfalfa hay or red clover hay, with or without silage or roots.

(1) 300 lbs. Ground or rolled oats

(2) 200 lbs. Ground or rolled barley OR ground corn OR rolled wheat OR hominy feed OR any combination of these feeds.

(3) 200 lbs. Bran OR equal parts of bran and shorts OR equal parts of bran and dried brewers' grains OR equal parts of bran and corn gluten feed.

(4) 100 lbs. Linseed oil meal OR soybean meal OR cottonseed meal OR ground soybeans OR any combination of these feeds.

800 lbs. Total Mixture.

17-19% TOTAL PROTEIN:—

(b) To be fed with mixed hay (chiefly grasses) or timothy hay, with or without silage or roots.

(1) 300 lbs. Ground or rolled oats.

(2) 200 lbs. Ground or rolled barley OR ground corn OR rolled wheat OR hominy feed OR any combination of these feeds.

(3) 200 lbs. Bran OR equal parts of bran and shorts OR equal parts of bran and dried brewers' grains OR equal parts of bran and corn gluten feed.

(4) 200 lbs. Linseed oil meal OR cottonseed meal OR soybean oil meal OR ground soybeans OR any combination of these feeds.

900 lbs. Total Mixture

Mix 1 to 2 lbs. of salt with each 100 lbs. of meal mixture.

Mix 2 lbs. of feeding bone meal with each 100 lbs. of mixture.

OR

Provide commercial mineral mixture in amounts recommended by manufacturers.

FEEDS AND FEEDING POINTERS:—

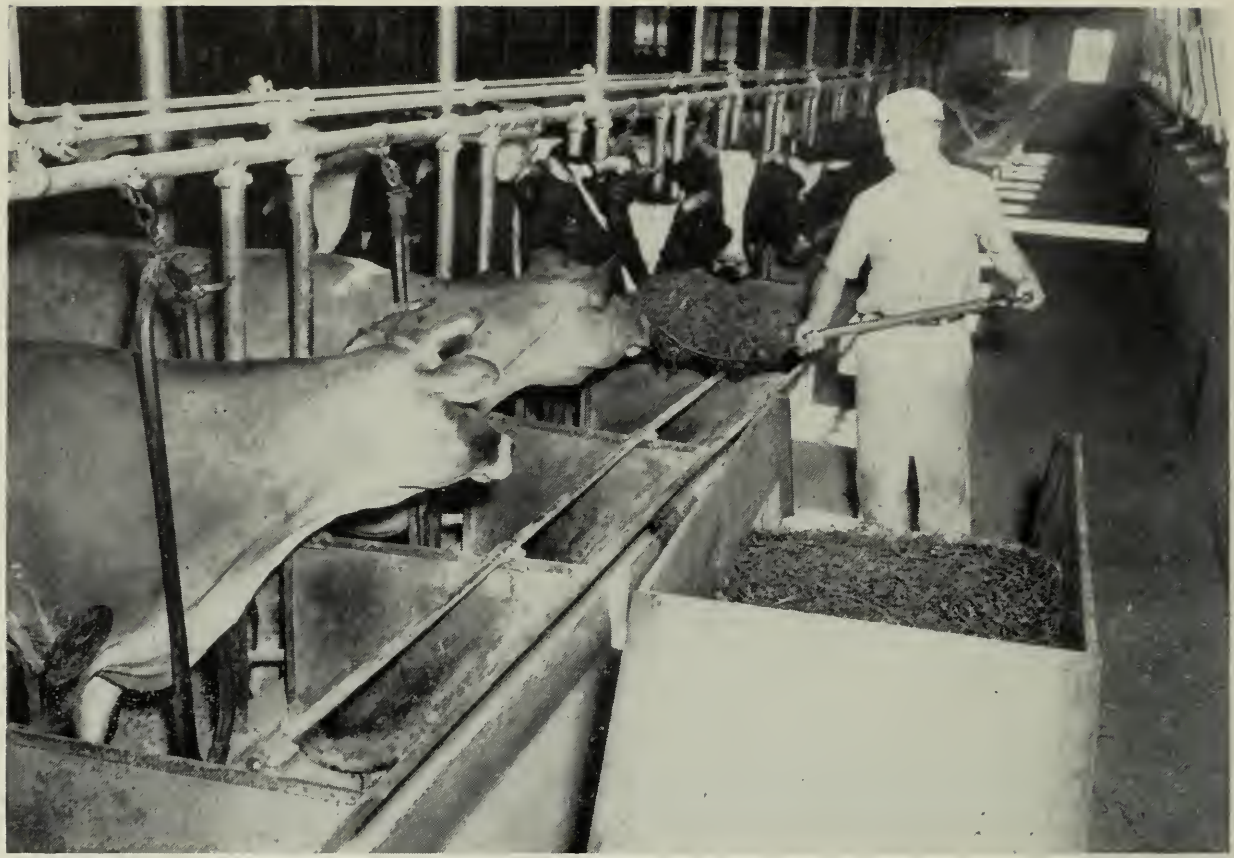
1. A basic standard for the meal mixture for milking cows is:
   Total protein 15-19% (depending on roughage)
   Total digestible nutrients 72-77%
   Total fibre not more than 10-12%
   Total fat 3% or more.
2. Avoid fine grinding — coarse grind or roll grains.
3. Feed according to the needs of each animal.
4. Feed definite amounts at regular hours.
5. Avoid sudden changes in the amount and the kinds of feed.
6. Keep mangers clean and sweet.
7. Provide adequate amounts of not too cold water.

SUGGESTED FORMULA FOR 24% DAIRY CONCENTRATE:—

1.	Bran	200 lbs.
	Gluten Feed	200 lbs.
	Dried Brewers' Grains	200 lbs.
	Linseed Oil Meal	200 lbs.
	Soybean Oil Meal	150 lbs.
	Iodized cobaltized salt	20 lbs.
	Bonemeal or cattle mineral	30 lbs.

SUGGESTED FORMULA FOR 32% DAIRY CONCENTRATE:—

1.	Bran	100 lbs.
	Gluten Feed	100 lbs.
	Linseed Oil Meal	400 lbs.
	Soybean Oil Meal	300 lbs.
	Iodized cobaltized salt	30 lbs.
	Bonemeal or cattle mineral	70 lbs.



Feeding time — Regularity of feeding and the correct amount add up to a healthy appetite.

STABLE FEEDING

Best results in rationing cows during the stable feeding period are obtained when emphasis is placed on the feeding of liberal amounts of good quality roughages rather than on the feeding of large amounts of grain concentrates. However, cows capable of producing large amounts of milk will not reach or maintain a high level of production if fed roughage feeds only. They cannot eat enough of the bulky feeds to supply all the nutrients required and the grains and by-products must be used to provide a portion of the nutrients in a more concentrated form.

The best hay for cows is green coloured, leafy, fine-stemmed legume or mixed grass and legume hay free from mould, mustiness and weeds. In general cows should receive all the hay they will eat without undue waste. More good quality hay will be consumed than poor quality stemmy coarse hay and the intake is greater when fed three times a day than when fed twice a day. If the hay supply varies in quality, feed some good hay and some inferior each day rather than all the good hay for a time and then all the poor hay. Also under these conditions an attempt should be made to give the high yielders rather larger amounts of good hay than the nearly dry cows. Silage, corn or grass, of good quality makes an excellent roughage type feed for cows and growing heifers. The amount consumed will depend on the quality of the silage and on the volume of hay fed.

Root crops, such as mangels, make an excellent feed for milking cows. However, the high cost of production makes this type of feed too expensive for general use. When available the root crops are usually confined to feeding during the freshening period or to the very high yielders.

Knee deep in luscious pasture fills the milk pail.

The amount and kind of grain mixture needed is dependent on the amount and quality of roughage fed. In general, the more nearly the roughage is all-legume the lower the amount of protein needed in the grain mixture.

SUMMER FEEDING

Fresh green pasture is the most nearly ideal feed for dairy cows. Excellent pasture is capable of supporting higher milk production than ordinary barn feeding and is the most important single factor in economical milk production. Unfortunately the period of time that excellent pasture is available is often quite short and to provide sufficient nutrients for high milk production supplemental feeding is necessary.

Spring pastures are high in water content, rich in protein, low in fibre and palatable. As pastures mature the protein content lowers, the fibre increases, and palatability and digestibility decrease. A proper appreciation of the wide variation in the feeding value of pasture throughout the season is fundamental. The lack of uniformity can be overcome only by proper management, the use of emergency pasture crops, green feeds, silage, and grain feeding.

The more important considerations in pasture management are the avoiding of too early grazing and overgrazing, seeding, fertilizing, and the controlling of weeds and excess growth. Overgrazing reduces the yield, increases injury from drought and encourages the growth of weeds. Undergrazing is not as common or as serious a fault as overgrazing; however, it is wasteful and stimulates the growth of coarse woody herbage. Harrowing pasture land late in the fall will tend to spread the manure droppings and prevent excessive bunching of the pasture.

Annual pasture is useful in supplementing regular pasture.

The amount of grass consumed daily varies and intake is dependent chiefly on the palatability and the abundance of the pasture. Medium to large sized cows will eat from 125 to 150 pounds of grass per day which should provide nutrients sufficient to maintain the cow and a level of milk production at about 30 to 35 pounds per day. These are nearly maximum figures and would apply only under nearly ideal conditions.

Since many cows produce more than 35 pounds per day on pasture extra feed is necessary if herd production and body weight are to be maintained. Grain feeding cows when on pasture requires careful thought and management on the part of the feeder to prevent wastage of feed on one hand or a drop in milk yield and in body weight on the other. Feeding schedules are given, but before applying, due consideration should be given to the pasture conditions, the time of the year, and the level of milk production.

AMOUNT OF CONCENTRATES TO FEED ON PASTURES

Milk Produced Daily on Good Pasture (lbs.)	Pounds of Concentrates Required Daily According to Milk and Test of Milk				
	3.0%	3.5%	4.0%	4.5%	5.0%
15					1.2
20	1.5	2.0	2.4	3.8	4.2
25	3.0	3.6	4.2	5.6	6.2
30	4.5	5.2	5.9	7.5	8.2
35	6.7	7.6	8.5	10.3	11.2
40	8.2	9.2	10.2	12.1	13.2

Since young grass is high in protein the grain fed while the cows are on this need not have a high protein content but should supply readily available nutrients to meet the energy requirement. Home grown grains may suffice. As the pasture herbage matures the protein content of the grain mixture should be increased. In selecting a grain mixture due consideration must be given to the condition of the pasture, the production of the cattle, the price of the feed, and the market price of the product.

GRAIN MIXTURES FOR COWS ON GOOD PASTURE

1.	Oats	200 lbs.
	Barley	100 lbs.
2.	Oats	200 lbs.
	Barley	100 lbs.
	Wheat	100 lbs.
3.	Oats	100 lbs.
	Barley	100 lbs.
	Wheat	100 lbs.
	Soybean Oil Meal	50 lbs.
4.	Oats	200 lbs.
	Wheat	100 lbs.
	Rye	100 lbs.
	Linseed Oil Meal	100 lbs.

GRAIN MIXTURES FOR COWS ON POOR TO MEDIUM PASTURES

1.	Oats	200 lbs.
	Barley	100 lbs.
	Wheat	100 lbs.
	Soybean Oil Meal	100 lbs.
2.	Oats	200 lbs.
	Wheat	200 lbs.
	Dried Brewers' Grains	100 lbs.
	Linseed Oil Meal	50 lbs.
3.	Oats	300 lbs.
	Barley	100 lbs.
	Soybean Oil Meal	100 lbs.
4.	Oats	200 lbs.
	Barley	100 lbs.
	Corn Gluten Feed	100 lbs.
	Linseed Oil Meal	50 lbs.

Improved pasture provides a large yield of nutrients per acre and is the corner stone of the summer feeding programme. Adverse weather conditions, winter killing and other factors may reduce the pasture yield, and roughage from other sources is needed. Silage made from corn or grass is very satisfactory for this purpose. To have corn silage available it must be saved from the material stored in the previous season. If this is not available, the excess growth of early pasture or some of the hay crop could be ensiled early in the season and fed out during the mid-summer season as grass silage. Material of this type is used to make up for the inadequacy of pasture volume not as a substitute for grain feeding.

Occasionally emergency crops are used to make up for lack of pasture volume. Green oat pasture, sudan grass, millet and other growing crops or

For the milking herd the aftermath of hay fields is a good source of pasture.

combinations can be used for this purpose. These emergency or temporary pastures do not yield as much as those regularly used, often do not stand treading well and always necessitate labour and expense in seeding. They are important as supplements to the regular pastures and in lengthening the grazing season.

Sudan grass, a member of the sorghum family, makes an excellent midsummer pasture, particularly during a hot, dry season. It is a high yielder, is very palatable and a good milk producer and should be seeded late in May or early in June at the rate of 25 to 30 pounds of seed per acre. Unfortunately, this crop has some liabilities. The seed is often expensive and may have poor germination. During a cold and a wet season the yield is frequently low and like all members of the sorghum family there is some danger from prussic acid poisoning. Sudan grass is not a serious offender, but as a precautionary measure do not pasture when the plants are small or when badly stunted or frozen. Turn the cows on the pasture when it is 18 to 20 inches high. In districts where corn can be successfully grown, sudan grass has possibilities as a temporary pasture crop, particularly during hot, dry seasons.

Fall rye seeded at the rate of about two bushels per acre between August 1st and 15th is useful as late-fall and early-spring pasture. In pasturing rye care must be exercised to prevent a feed flavour occuring in the milk. Allow the cows on rye pasture for a few hours each day, and have them off the rye for about two hours before milking time to overcome flavour difficulties. Some dairymen mix oats with the rye to thicken the pasture for fall grazing.

Green Feeds or Soiling Crops

Soiling crops are cut in the green stage, hauled to the barn or pasture field, and fed as green feed. They are of considerable value in keeping up milk flow, particularly when pasture is scarce. Unfortunately a large amount of labour is required in growing and harvesting, but this method of supplying feed is very efficient in the utilization of the green material. There is little wastage, good response is observed in maintained or increased milk yield, and large amounts of feed can be grown on a small acreage. Alfalfa for cutting early in the season and corn for use later makes good soiling crops.

Miscellaneous Pasture Pointers

Cows are creatures of habit and respond to regularity and routine in management practice. In addition to supplying a uniform amount of roughage throughout the summer season and supplementing this where necessary with grain some attention must be given to factors other than feeding if high milk yield is to be maintained.

Cows require large amounts of fresh water, milk contains about eighty-five per cent. If possible have a continuous supply of fresh water in the pasture field and definitely avoid stagnant water from mud holes and swamps. While not absolutely necessary, shade undoubtedly adds much to the comfort of the cattle. A few trees in the field or along the fence line will give protection against the sun during the heat of the day.

Regular pastures must of necessity be a part of the farm crop rotation. Wherever possible, however, pasture land should be located near the barn. Walking cows long distances to and from the pasture field is not conducive to high milk yields for, in addition to using much energy, it predisposes the cows to udder injury and sore and cracked feet.

FEEDING THE COW DURING THE DRY PERIOD

Dairy cows should be given a rest by drying them about 6 to 9 weeks before refreshening. A longer rest period may be necessary to properly fit very thin cows or the young cows that may need extra size. Records of service dates are necessary to insure a dry period of adequate length yet not so long that many of the cows are non-productive for many months. The milk market and the market for surplus breeding stock are factors to consider in planning the dates of breeding, rest periods and freshening dates.

Drying the cow may be difficult particularly if she has been milked to within two or three weeks of freshening. If this has happened it is wise to continue milking, feed liberally and expect production in the next lactation period to be low. Cows, some weeks from freshening, may be dried by reducing the feed and water intake, milking occasionally and if possible removing them from the regular milking line.

Another method of drying is to discontinue milking abruptly. Change the milking routine, remove the protein rich feeds and reduce the grain and the water intake. Allow the udder pressure to build up and in this way prevent the secretion of milk. If the udder should become unduly congested milk out thoroughly and start over. This method is not advised for cows with a history of mastitis trouble.

After drying, the cow should be liberally fed to increase body weight, build up a reserve of minerals and develop a strong vigorous foetus. This requires the use of good roughages and of grain mixtures that are more than just fattening feeds. The regular production grain ration is satisfactory or a special dry and fitting mixture could be used.

FORMULA FOR DRY AND FITTING GRAIN MIXTURE

Rolled Oats	400 lbs.
Rolled Wheat	100 lbs.
Corn and Cob Meal	50 lbs.
Wheat Bran	100 lbs.
Beet Pulp	50 lbs.
Linseed Oil Meal	170 lbs.
Molasses	100 lbs.
Bonemeal	20 lbs.
Cobalt – Iodized Salt	10 lbs.

The amount of grain fed will depend on the condition and size of the cow. It may range from only a few pounds to eight or ten pounds per day. Cows in good condition on pasture are not likely to require additional feeding in the form of grain.

As calving time approaches it may be necessary to reduce both the amount and kind of grain fed because heavy feeding up to freshening may result in excessive swelling and congestion of the udder in some cows. If signs of this type of trouble are in evidence reduce the volume of grain mixture fed and switch to a simple laxative type of feed. The following combination is suggested for feeding just prior to and also after freshening until the udder swelling and congestion have been reduced:

Oats (rolled)	250 lbs.
Wheat Bran	100 lbs.
Oilcake	50 lbs.

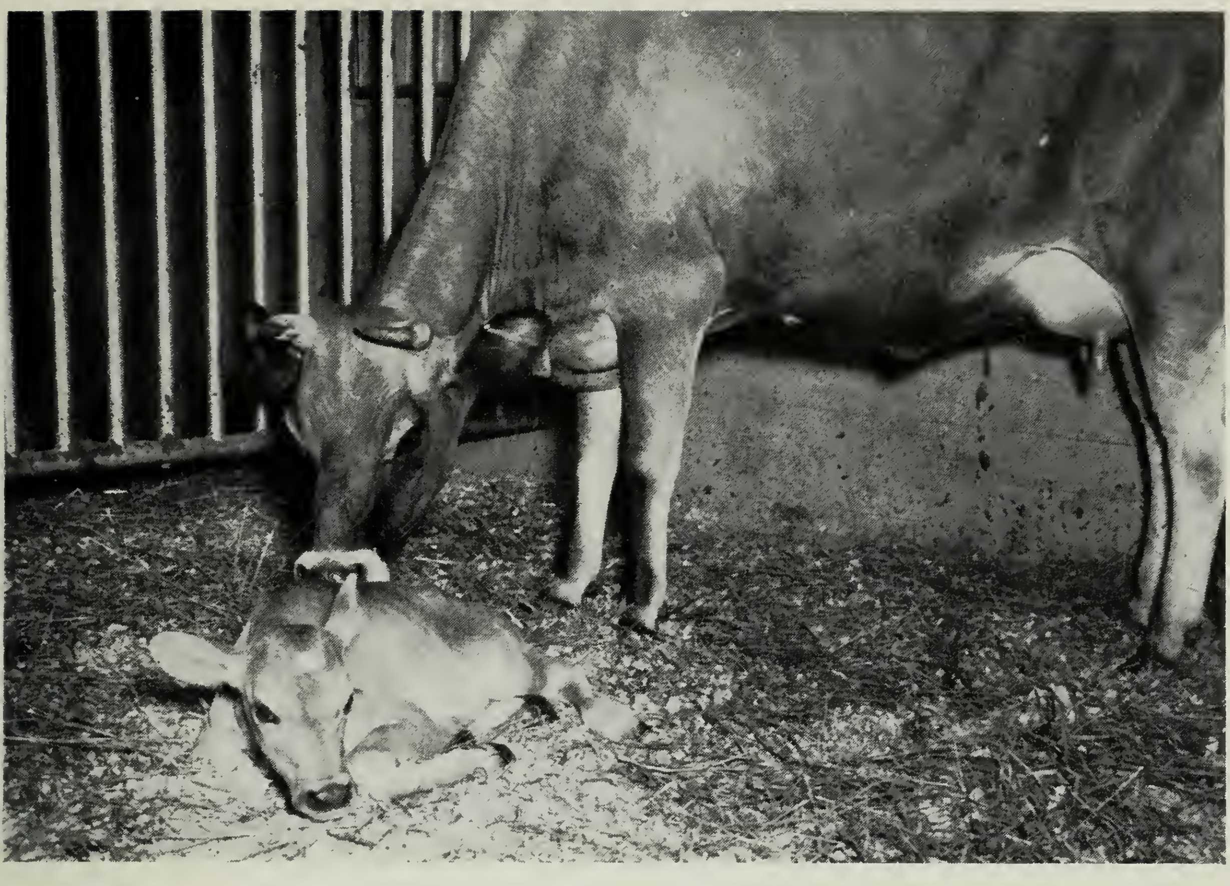
Premilking (milking the cow before calving) will, in at least some cases, prevent undue swelling and congestion. Certain factors should be appreciated before starting a management change of this type otherwise more harm than good may result.

1. Commence premilking before the udder becomes extremely hard and congested. This may vary from a few days to a month before freshening.
2. Once started continue milking – only a small amount of fluid will be obtained in the first milkings but the amount of secretion should increase after a few days. Do not start the secretion process and then because of the small amount of milk, extra work, or for some other reason discontinue milking.
3. Premilking, when properly done, will not injure the cow. Trouble in raising the newborn calf may result from the changed character or the absence of colostrum.

Cows vary in symptoms indicating calving but the individuals are fairly constant in the symptoms at each lactation. Some "make-up" quickly, others slowly. The signs indicating the approach of calving are:

1. Swelling of the udder with the teats filling and showing a waxy appearance a few hours before freshening.
2. The vulva is swollen and a relaxing of the muscles around the tail head is characteristic.
3. Restlessness and if on pasture a tendency to segregate from the main part of the herd.

During the stable feeding period the cow should freshen in a clean disinfected, well bedded box stall. Even during the pasture season it is wise to freshen the cow in a box stall or a paddock near the barn where she can be observed frequently. After freshening the cow should be allowed to lick the calf, kept warm and be fed sparingly. A drink of warm water and a warm bran mash, improved by the addition of molasses, is a recommended practice in getting the cow over the strain of calving. Observe the cow at intervals to detect the early symptoms of milk fever or acetonemia. (See section on diseases). If the afterbirth membranes are not expelled after approximately two days procure the services of a veterinarian.



Off to a good start — A clean stall, and a healthy cow.

FEEDING AND CARE OF THE CALF

Shortly after birth the calf should nurse. The colostrum or first milk has properties that apparently activate the digestive tract of the newborn calf and also builds up the resistance to disease. Disinfecting the naval stump with a weak solution of tincture of iodine will serve to guard against infection entering at this point.

The calf could be left with the dam for a few days or may be removed within twenty-four hours of the time of birth. With cows that have a bad udder congestion leaving the calf with the cow for a time may tend to relieve the condition. However, under all circumstances the udder should be watched to detect undue swelling in individual quarters, sore teats or injuries. Leaving the calf with the cow for several days may predispose it to a scouring condition from overfeeding and also makes it more difficult to train the calf to drink from a pail.

Points to Consider in Rearing Young Calves

1. *Regularity of feeding* – The young calf will often respond to more frequent feeding than the usual morning and evening feeding practices which are sufficient when the calf has reached the age of one week to ten days.
2. Uniformity in quality, temperature (in case of milk), and quantity of feed.
3. Cleanliness of *all* feeding utensils.

An individual pen ensures comfort and health.

4. Keep calves dry, clean, free of external parasite and in a well lighted properly ventilated pen.
5. Avoid under-feeding or over-feeding.
6. Allow opportunity for calves to take exercise.

Various methods of feeding calves are used after they have reached approximately three weeks of age. Regardless of the feeding procedure used whole milk should be fed for at least a three week period following the first few days on colostrum. The amount of milk required will vary with the breed and size of the calf but will be near eight to ten pounds per day. During the third week on whole milk a gradual change could be made in the feeding schedule to reduce the cost of feed and possibly the amount of labour. The methods might be listed as:

A. Skimmilk feeding

B. Limited whole milk supplement with calf meal

C. The use of milk powders, usually dried skimmilk

D. While not a part of the pail feeding program, some dairy calves are raised on nurse cows.

Where skimmilk is available it may be gradually substituted for the whole milk commencing the change when the calf is about 3 weeks old. At about four weeks of age the calf should be fed daily about 10% of its body weight in skimmilk. This amount could be gradually increased to about sixteen pounds daily and fed at this rate until the calf is 4-5 months of age. If available, feeding for a longer period is advised but regardless of age the transition from skimmilk feeding to dry feed rationing should be made gradually. Calves being reared on skimmilk should receive in addition to the milk liberal amounts of good quality hay, some grain, salt, mineral and regulated supplies of water.

TABLE NO. 7. FEEDING SCHEDULE FOR SKIMMILK FED CALVES

Age of Calf	Whole Milk	Skimmilk	Grain Mixture *	Hay	Mineral
1-3 days	(Lbs. Daily) With dam or milk from dam	Lbs. Daily)			
3-14 days	8 - 10	None	None	None	None
3rd week	11 - 5	0 - 6	Small amount in pail	All will eat	Cattle mineral mixture. All will eat.
4th week	5 - 0	6 - 12	About ¼ lb.		
5th and 6th week		12 - 14	Increase slowly to ¾ lb.		
7th to 20th week or older		14 - 16	¾ to 3 lbs.		

* Oats	250
Bran	100
Oilcake	50

The total amount of whole milk allowed is approximately 350 pounds per calf. Calves of larger breeds of dairy cattle should receive greater amounts per day than calves of the smaller breeds but fed for a shorter period of time. Milk should always be fresh and fed at same temperature — about 95° to 98° F.

First week — Leave the calf with cow for at least one day and not longer than four days. It is then taught to drink out of a pail and the amount of milk per feed will vary, depending upon the size and appetite of the calf, but not more than eight lbs. of whole milk per day. Normally a calf will consume milk equal to about 8% of its body.

Second week — Whole milk increased gradually to not more than 10% of body weight or from eight to ten pounds daily.

Third week — Whole milk not to exceed ten pounds daily.

Fourth week — Whole milk not to exceed nine pounds daily.

Fifth week – Whole milk not to exceed seven pounds daily.

Sixth week – Whole milk not to exceed six pounds daily.

Eighth week – Whole milk not to exceed four pounds daily.

The dry calf starter is given at the beginning of the third week. The calves are allowed all they will eat twice daily until they are consuming up to an average of four pounds per day as a maximum for the larger breeds. The calf starter is fed dry in a feed box or trough, allowing no stale feed to accumulate. Feed manufacturers have prepared calf starters, some of which are in dry-meal form and others in pellet form. Calves will usually eat concentrates which are coarse or fairly bulky in nature more readily than finely ground mixtures. Provide fresh, clean water in the pen as a drink at three weeks of age and thereafter. Care should be taken to see that the calf does not drink too much water. When several weeks old the calves can gradually be changed from the calf starter ration to a heifer mixture or any good fitting ration or even rolled or whole oats. If not incorporated in the calf meal salt and a mineral mixture should be made available. Good quality hay is one of the most important feeds for dairy calves because of its vitamin content, minerals, and the effect on body development. If legume hay is fed, care should be taken that it does not cause scouring in the calves.

Reconstituted powdered skimmilk, made by mixing one pound of powder with 8-9 pounds of water, makes an excellent but often quite expensive feed for calf rearing. The reconstituted product can be used in the same manner and fed at the same rate as fresh skimmilk. Dried buttermilk may be used in the same way as dried skimmilk but often lacks palatability and difficulty is encountered in getting at least some of the calves on this type of feed. Very satisfactory new products for calf feeding made from milk constituents are being offered on the market. The use of these in feeding, like all milk powders, is governed by price and procurability.

Nurse cows particularly on large farms where some older brood cows may be available, are used quite successfully to rear calves. Several calves may be reared on one cow throughout a lactation period. The calves should not be left with the cow continually and her udder should be closely watched to detect injuries and irregularities in the nursing of the quarters. Calves reared on nurse cows should have free choice of hay, be fed some grain and have access to salt, minerals and water.

Regardless of the method used in rearing certain management factors must be given careful consideration if disappointments are to be avoided. Good quality in the feeds, regularity in feeding routine, cleanliness of feeding utensils and calf pens, freedom from draughts and excessive humidity in the winter stabling-quarters and protection from heat and flies while on pasture are but a few of the factors that play an important role in successful calf rearing.

Efforts should be made to reduce sucking. An individual calf pen is the best solution but if this is not possible leave the calves tied for a time after pail feeding and give some dry feed in the pail. This habit may seriously distort the udder in its formative stage and has been known to persist even after the calves have developed and come into production.

Table No. 8. Suggested Schedule for Dry Calf Meal Feeding

Age of Calf	Whole Milk (Lbs. Daily)	Calf Meal	Grain Mixture *	Water	Hay
1-3 days	With dam or milk from dam				All calf will clean up. Feed fresh daily.
3-14 days	8 - 10				
3rd week	10	Small amount in pail. Small amount (dry) in feed box.		Warm water. 1-2 lbs. with milk.	
4th week	9 - 7	Keep dry feed before calf. Keep box clean and meal fresh.		Gradual increase to compensate for reduced milk intake	
5th week	7 - 6	Same as 4th week		Same as 4th week	
6th week	6 - 5	1½ to 2 lbs. per day	About 1½ per day	Should be getting about 15 lbs. daily	
7th and 8th week	4 - 0	2 to 3 lbs. per day	About 2 lbs.	All water calf will drink	
8th week on to 20th	—	3 lbs. or probably more for large calves	Increase until getting about 2-3 lbs.	All water calf will drink	

This schedule should not replace the manufacturer's schedule. Calf meal will contain necessary minerals.

* Grain mixture could be oats 250; bran 100; oilcake 50; or any good 16% dairy ration or oats alone. For good results in dry calf feeding liberal amounts of good quality hay are essential. Watch the temperature and the amount of water consumed when changing from milk to dry feeding.

Horn growth can be stopped when the calves are young by applying one of the caustic preparations or using electric dehorners on the developing horn buttons. Identification, by tagging, tattooing or drawing, should be recorded at an early age to avoid errors. Extra teats are easily removed on calves and excessive foot growth should be trimmed off. A bad infestation of lice may be the cause of unthriftiness and a calf with a dry shaggy coat should be examined for external parasites. If the herd is operating under a vaccination program have the calves vaccinated when from six months up to eight months of age. Haltering and tieing occasionally will greatly reduce the labour involved in halter breaking.

The period of changing from calf feeding may cause a serious setback unless certain precautions are taken. As the calf reaches this stage, about 5-6 months old, make certain it is feeding on liberal amounts of dry feed and reduce gradually the milk or milk substitute. Aim to keep the calf growing, avoiding extreme thinness on one hand and excessive fatness on the other. All the good hay and silage the heifer will consume may be sufficient to keep it in proper condition but two to four pounds per day of a simple grain mixture may be needed to supplement the roughage feed. Minerals and salt should be made available.

Age to Breed

Heifers well grown for age can be bred earlier than those that are underdeveloped. Freshening at the most desirable season of year from the standpoint of marketing the milk may be a governing factor. The smaller breeds usually mature at a somewhat younger age than larger breeds. Table No. 9 will serve as a guide to the proper age to breed well developed heifers for first gestation period.

TABLE NO. 9. AGE TO BREED

Breed	In Months
Holstein	18 to 21
Ayrshire	17 to 20
Guernsey	16 to 19
Jersey	15 to 18

Normal Growth

It is helpful to have a normal standard in order to determine whether young cattle are making the proper rate of growth. Weight at a certain age, weight for height at withers and weight for heart girth measurement are different types of standards used to measure the rate of growth and development. Morrison in Feeds and Feeding presents a very complete summary of the experimental work on growth. The average weight at one year of age for Ayrshires was reported as 518 pounds; Guernseys 490 pounds; Holsteins 653 pounds; and for Jerseys 462 pounds; growth is less rapid during the second year than the first. In all breeds males are heavier and make more rapid gains than females.

TABLE NO. 10. NORMAL GROWTH IN WEIGHT AND HEIGHT OF DAIRY CATTLE

	Ayrshire Heifers		Guernsey Heifers		Holstein Heifers		Jersey Heifers	
Age	Weight lbs.	Height ins.	Weight lbs.	Height ins.	Weight lbs.	Height ins.	Weight lbs.	Height ins.
1 mo.	86	27.0	79	28.4	113	30.5	68	26.9
2 mo.	114	28.4	105	30.0	150	32.2	92	28.8
4 mo.	190	32.0	177	33.7	250	36.2	164	32.7
6 mo.	281	35.3	267	37.2	365	39.8	250	36.2
8 mo.	371	37.7	350	39.9	474	42.4	331	39.1

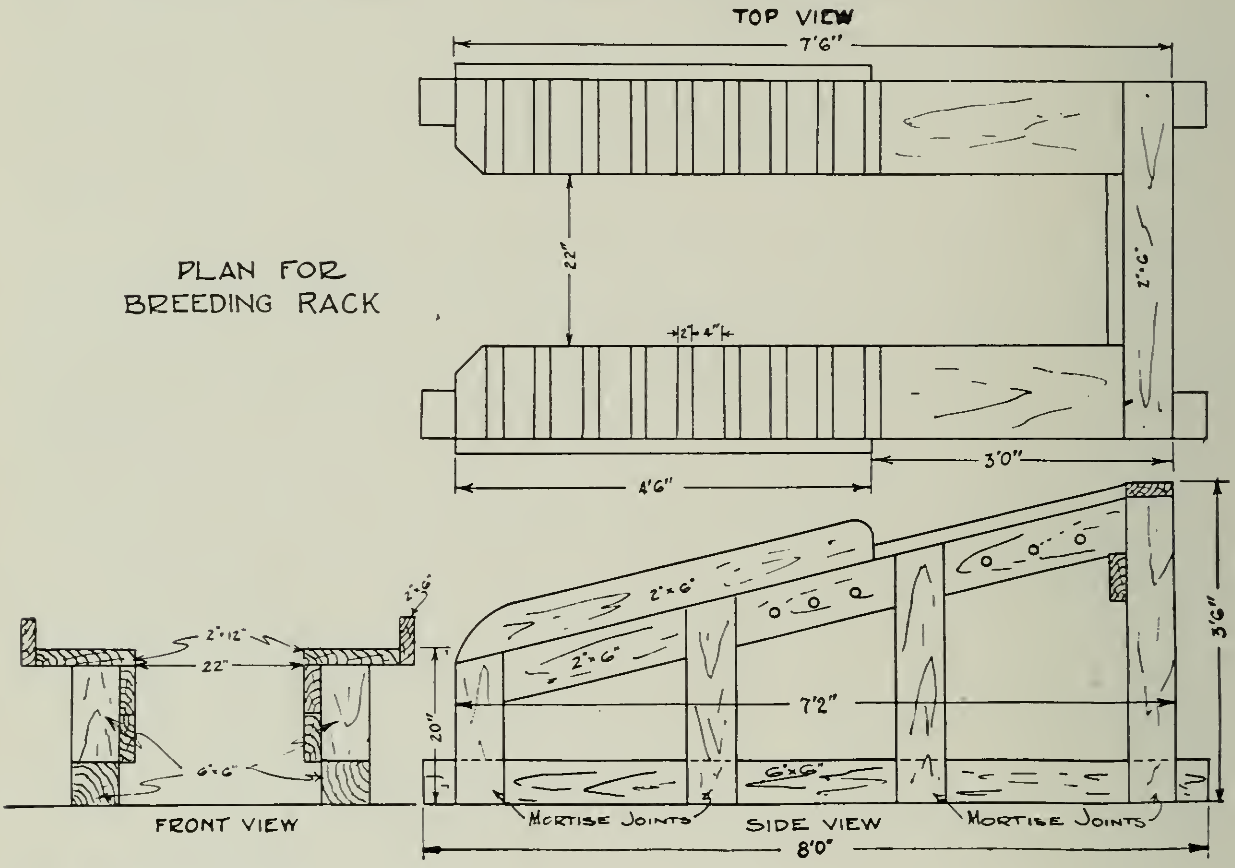
Veal Production

Each year many dairy calves are marketed as veal. Nothing but whole milk will produce veal of high quality and it requires about ten pounds of milk to produce one pound of gain. A veal calf nursing seems to do better than one that is pail fed on whole milk. The original weight of the calf, the value of milk, the price of veal and the availability and efficiency of labour are some of the factors that must be considered in evaluating the efficiency of veal production.

FEEDING AND MANAGEMENT OF THE BULL

The Young Bull

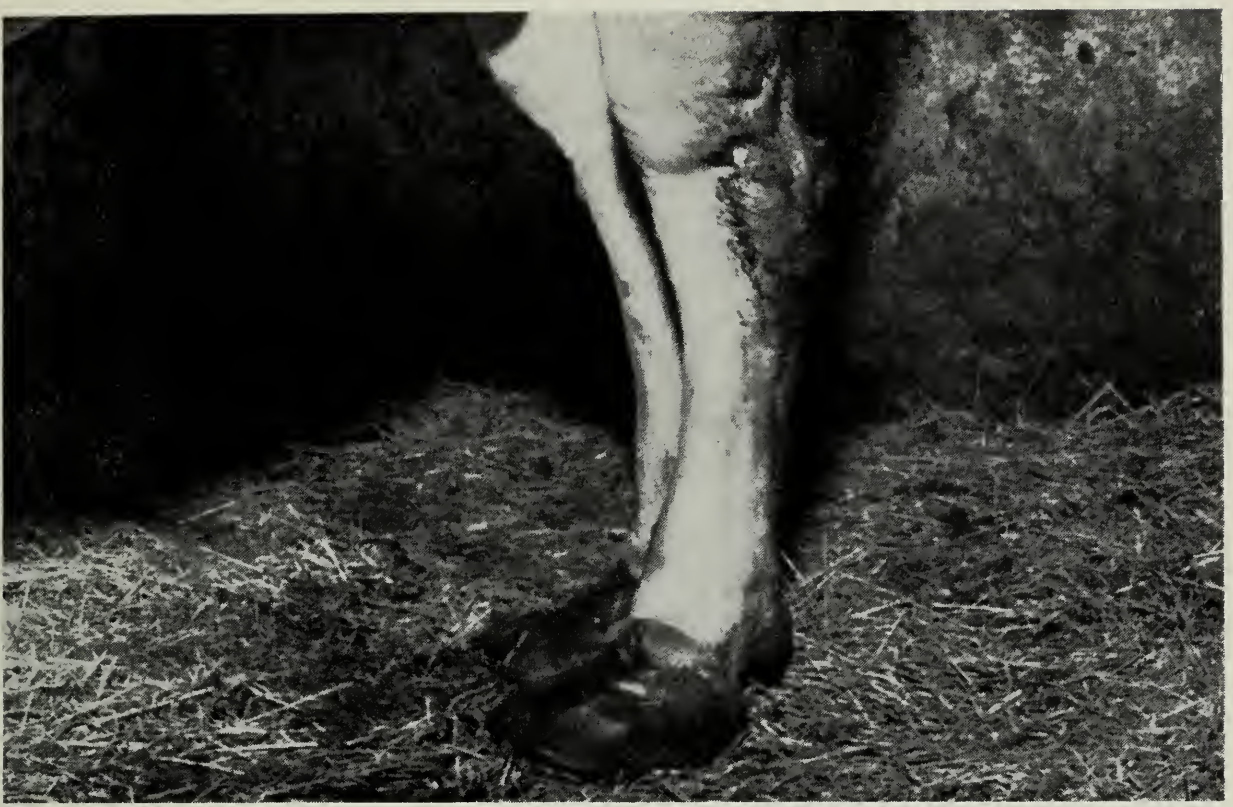
The feeding and management of the young bull calves is essentially the same as that followed in rearing the heifer calves. However, as bull calves are usually raised for sale the feeding of milk substitute is often continued for a longer period of time than with the heifers. They should be separated from the heifer calves when about six months of age and as far as feasible kept in individual pens. Feed liberally on hay and grain and in the winter, provide limited amounts of silage and in the summer some green feed. Allowing the young animals outside for some time each day will insure exercise resulting in stronger legs and better shaped feet. When about one year of age a ring should be put in the nose and some stern handling practised during this period may serve to make the bull more manageable throughout his lifetime. Well grown bulls may be put at light service when about twelve months old but heavy service at this age may impair the future usefulness by making him a slow, indifferent or impotent breeder.


PLAN FOR BREEDING RACK

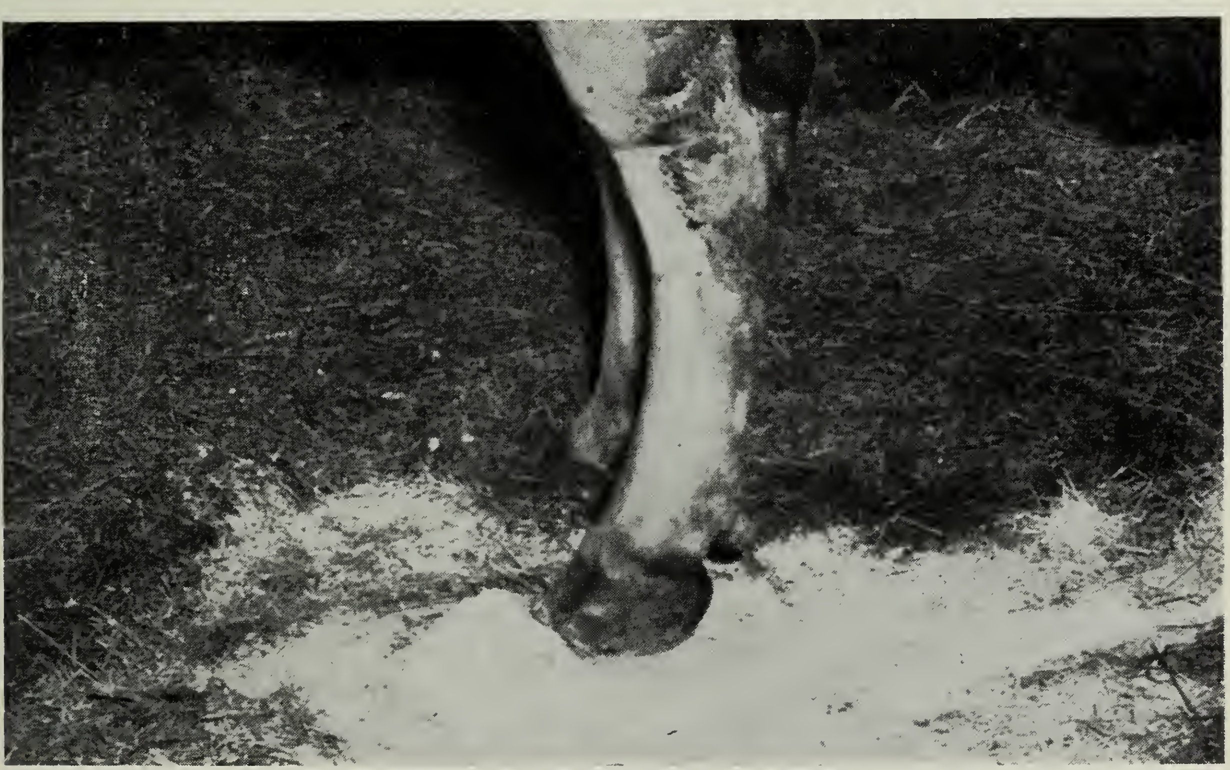
The Breeding Bull

Breeding bulls that are in heavy service in large herds or in artificial insemination units may require special rations. However, bulls in the average sized dairy herd can be kept in good breeding condition on the same type and mixture of feeds as used in rationing the cows. The amount of succulent feed such as silage may have to be reduced below the amount fed the cows. The amount of grain fed would range from very little to eight pounds per day depending on the condition of the bull and the number of services.

Faulty management reduces the efficiency of many bulls. Inadequate stable facilities, no exercise yards and lack of safety measures make the care of the bull a difficult and oft times dangerous task. Nevertheless a bull should get exercise, fresh air and during the summer some green feed. If a bull is



Do not overlook the feet — Note the condition of these feet.



The same feet correctly trimmed.

regularly kept on a farm some provision should be made for a strong safe box stall with an adjoining well fenced exercise yard. This type of equipment reduces the need for handling to a minimum. Over-feeding may render a bull impotent but gross under-feeding is the more common cause. Keep the feet in proper shape, watch for worn or weakened rings and never handle the bull with a weak staff or a frail lead rope. Do not abuse but never trust a bull.

MILKING PROCEDURE

Feed and Milk Quality

There is no evidence that any feed or combination of feeds will increase the butterfat test for an indefinite period of time. Prolonged under-nutrition will tend to lower the test and when this condition is rectified an improved test will be noted. This is a return to the normal level after a period of low test. Sudden changes of feed may cause fluctuations.

Feeds may cause off flavour in milk. Turnips, some silages and green feeds are common offenders. Give troublesome feeds after milking and remove from the offending pasture a few hours before milking. Immediately removing the milk from the stable and rapidly and adequately cooling it will help to prevent undesirable flavours.

Milking Technique

Careful hand milking or skilful operation of the machine is essential for good milking and the maintaining of udder health. The machine lines should be kept clean, inflations properly adjusted and free from cracks or holes, vacuum maintained at the proper level and the speed of the pulsations adjusted to the manufacturers' instructions. The machine operates twice daily on delicate tissue and should receive more detailed care in both maintenance and operation than a piece of ordinary farm machinery.

Dr. W. E. Petersen, an eminent authority on milking procedure, gives five rules as guides for proper milking:

Rule 1: Avoid excitement of cows either before or during milking.

Rule 2: Stimulate let-down about one or two minutes before milking is to begin. The most effective stimulus is a vigorous massage of the teats and the lower part of the udder by a cloth taken out of water as hot as the hands will stand.

Rule 3: In hand milking use the full hand grasp of the teat. In machine milking operate the milker according to the directions of the manufacturer and see that it is in good working order.

Rule 4: Begin stripping as soon as the teat cups crawl upward.

Rule 5: Remove the milker as soon as the milk stops flowing.

Butterfat Tests

All cows vary in butterfat test and an individual test of a milking during a lactation period may range from near two to over eight per cent but despite this wide range there is a tendency for the tests to remain near an average. One test may be definitely misleading in determining the average production of a cow but tests made at intervals throughout the lactation period do give accurate information on the ability of the cow to produce fat.

Herd tests are often lower in the late winter and early spring than at other seasons of the year. The low period of test in the lactation is about six to eight weeks after freshening. There is a slight lowering in test as a cow reaches maturity. Tests made on three times a day milking are more uniform than those in twice a day milking. Mastitis tends to lower the test. Digestive disturbances, oestrum, extreme temperatures and any sickness may cause wide variations with one extreme often followed by another in the opposite direction. Rapid milking tends to increase the test; very slow milking lowers it.

The first drawn milk is quite low in fat, testing less than one per cent while the last of the strippings may test as high as eight or ten per cent. Complete and rapid milking enables the dairyman to get all of the milk and particularly the last-drawn high-testing portion. Milk secretion is a continuous process until udder pressure commences to build up, this lowering the rate of secretion eventually stopping it completely. This condition explains why heavy yielders may produce more when milked three times per day while with cows not in full flow of milk there is but slight response to increased times of milking.

HERD HEALTH

Ontario dairy cattle are among the healthiest in the world. Through the protection afforded by the Animal Contagious Disease Act and the veterinarians of the Health of Animals Branch who administer it, dairymen have been spared the plagues which make an efficient industry difficult if not well nigh impossible in many parts of the world. Great progress has been made in the fight against tuberculosis and the loss caused by brucellosis has been considerably reduced in recent years. But much remains to be done; in fact the fight against disease can never end. Disease still costs dairymen millions of dollars annually, a great part of which could be prevented. Admittedly there are diseases which cannot be combatted with full effect without more knowledge, and that knowledge can be gained only through research. For most diseases, however, methods of prevention and adequate treatments are at hand. In this bulletin, symptoms and control measures are indicated for some of the diseases which occur, or could occur, in Ontario dairy cattle. Success in diagnosis, treatment and prevention must be a co-operative effort between the herd owner and his veterinarian.

Mastitis

The term mastitis means inflammation of the udder regardless of the cause. However, in practice, mastitis is almost invariably due to bacterial infection, which gains entrance to the udder by way of the teat opening. It differs, however, from most of the infectious diseases in that it may be caused by any one of a number of bacterial species. These may cause an acute attack with heat, pain and swelling of the udder and leading occasionally to the death of the cow. More frequently the infection will lie apparently dormant for weeks or even months with infrequent acute flare ups. Gradually the secreting cells of the udder are replaced by hard fibrous tissue resulting in diminished quantity and quality of milk. It is through impaired function rather than death loss, that mastitis exerts its most destructive action but together they make it by far the most expensive disease with which the Ontario dairymen must contend.

The most common bacterial cause of mastitis, *Streptococcus agalactiae,* can live indefinitely in the udder of an infected cow but will usually die within a few weeks in other locations such as around the stall, on milk stools or on the hands or clothing of the milkers. These facts, along with the success which has been attained in freeing udders from this organism through the use of antibiotics, point to the possibility of removing this infection completely from whole herds or even wider areas by a well-planned and executed attack. However there are other bacteria capable of causing mastitis, some of which cannot be eliminated from the environment of the cow by practical means. Mastitis control must, therefore, be a continuous process attacking the sources of infection, blocking the avenues by which it is spread and reducing the environmental factors which tend to activate the disease.

Attention to the following points will assist in controlling mastitis:

1. *Have milk samples from all cows in the herd examined in a laboratory.* Identification of infected cows is necessary before the disease can be controlled effectively. Repeated sampling may be necessary to check the result of treatment. Samples submitted by veterinarians are examined without charge in laboratories maintained by the Ontario Department of Agriculture.

Early mastitis infection may be detected through the use of the strip cup.

2. *Have infected cows treated.* Recently infected cows respond well to treatment. Cows showing extensive fibrosis (hardening) of the udder should be sold for slaughter. If valuable as brood cows, they should be removed from the milking line.
3. *Milk infected cows last.* Infection may be spread by the machine or on the hands of the milker.
4. *Feed infected cows carefully.* Heavy feeding can aggravate an existing infection.
5. *Use correct milking procedures.* Speed and cleanliness are of first importance. (See Bulletin No. 484)
6. *Prevent udder injuries.* Adequate bedding, properly constructed stalls or loose housing and dehorning all help in this connection.
7. *Treat teat sores promptly.* They often harbor mastitis producing bacteria. Application after milking of an ointment containing sulfonamides or antibiotics will usually keep down infection and promote healing.
8. *Use a strip cup daily.* Cows giving flakes or clots in the milk can be detected at a stage when treatment is effective.
9. *Keep cows and barns clean.* Many mastitis producing bacteria live in filth.
10. *Prevent calves from sucking one another.* This breaks down the seal which closes the teat canal and may introduce infection leading to mastitis.
11. *Do not introduce infected animals into the herd.* Have the udders of all newly purchased cows examined and their milk tested before they enter the milking line.

Tuberculosis

Great progress has been made in the elimination of tuberculosis through area testing. The Restricted Area Plan now covers all inhabited territory east of the Great Lakes and the remainder of the country is rapidly being covered. Under the regulations of this plan, all areas established for the eradication of bovine tuberculosis are designated as "restricted area." When the incidence of tuberculosis in such an area has been reduced to .5 per cent or less, by testing all cattle therein and the slaughter of reactors, the area is called an "accredited area." Accreditation lasts for three years after which a retest is necessary. Individual herds may also be accredited but in recent years the emphasis has been placed on area testing.

While the incidence of tuberculosis among Ontario dairy cattle has been reduced to a very low level, continued testing is necessary to stamp out new infections which occur from time to time. Inquiries concerning the tuberculosis eradication program should be addressed to your nearest Sub-district Office, Health of Animals Branch, or the District Office, Health of Animals Branch, Canada Department of Agriculture, 366 Keele Street, Toronto, Ontario.

Foot-and-Mouth Disease

Until the outbreak in 1952, foot-and-mouth disease was of only passing interest to Canadian cattlemen. They now realize that it can happen here and that it can have a very serious effect on the whole livestock industry.

It is an extremely contagious virus disease which causes blisters and ulcers to form in the mouth and on the tongue, around the feet and, sometimes, on the udder. It affects only cloven footed animals. In most outbreaks the death rate, due to the disease itself, is low but there is a serious loss of flesh and milk and permanent crippling is not infrequent. If unchecked, an outbreak soon becomes an epidemic. Since infection does not produce permanent immunity and vaccination protects for only a few months, there is no doubt that the continued existence of the disease in this country would, in itself, be equivalent to a tax of many millions of dollars annually on the livestock industry.

The policy adopted by this country and the United States is to contain an outbreak by an immediate and rigid quarantine, slaughter all affected and exposed animals with compensation to the owners and to disinfect the infected premises. In this century six outbreaks have been stamped out in the United States through the use of this method and there can be no doubt as to its effectiveness when rigorously applied. When a cattle owner observes symptoms suggestive of foot-and-mouth disease he should inform his local veterinarian or nearest representative of the Health of Animals Branch, Canada Department of Agriculture, immediately.

Calf Scours

Diarrhoea in calves is largely a result of feeding errors and is seldom encountered when the rules mentioned in the section on calf feeding are observed. When uncomplicated cases occur, it is good practice to administer an ounce or two of castor oil, omit a feed of milk and restore the calf to full feed gradually over a period of several days.

Occasionally, outbreaks of infectious scours occur which may result in a high mortality. Calves are born apparently in good health but become ill during their first week. Scouring is usually a symptom although some calves may die without scouring. Death may occur within a few hours or the calf may last several days. Few untreated cases recover.

On farms where this disease exists, it is particularly important to have the calf born in a disinfected calving pen. In addition, dosing with appropriate sulfonamide drugs or antibiotics, starting immediately after birth and continuing for four or five days, will help prevent the disease. Attention to the nutrition of the dam, particularly with reference to vitamin A, may help build resistance to scours in the newborn calf.

Calf Pneumonia

Pneumonia (inflammation of the lungs) is one of the common reasons for death loss among calves. While bacteria and viruses play a part, its primary cause is generally thought to be inadequate stabling facilities, particularly dampness and poor ventilation. It may also be caused by careless drenching, causing medicinal material to pass down the windpipe into the lungs. Some cases occur as a sequel to prolonged scours.

As a rule the age group principally affected is from one month to three or four months. The most evident symptoms are high temperature, discharge from the nostrils and rapid labored breathing. Until sulfonamide and antibiotic therapy became available, the death rate was high among affected calves. Now early treatment saves the majority although cases which become chronic usually prove fatal.

Since the disease tends to spread, affected calves should be segregated immediately. It is advisable to break up the remaining calves into smaller groups as a means of avoiding overcrowding and further spread of the infection. Bacterins are of uncertain value. Probably the most important factor in preventing calf pneumonia is to provide proper ventilation and thus minimize dampness and draughts.

Foot Rot

Foot Rot is the most frequent cause of lameness among cattle in Ontario. It occurs most frequently when cattle at pasture have access to mud holes or are forced to walk through mud to obtain drinking water. However, it may occur among cattle stabled in apparently excellent conditions. The disease is caused by infection penetrating the skin around the top of the hoof or between the claws. Open sores are formed when portions of skin slough away. Occasionally infection invades the deeper structures and gets into one or more of the joints of the foot. These cases heal with difficulty and may even cause the death of the animal.

Individual cases should be kept in a dry place and treated promptly. Some recover rapidly if the foot is kept clean and treated with mild antiseptics or healing oils. The injection of soluble sulfonamide drugs into the blood stream or antibiotics into the muscle are the treatments preferred by most veterinarians.

If the disease becomes a herd problem, placing a trough containing a coal tar disinfectant solution so that the cattle are forced to walk through it once or twice a day will keep down the number of new infections.

Warts

Warts are unsightly growths which appear most frequently around the head and neck of young cattle or on the teats and udder of milking cows. They are mildly infectious and show some tendency to spread from animal to animal. Large warts may attain a weight of a pound or more and, if in an exposed place, become so raw and painful as to interfere with growth and development. Small warts on cows' teats interfere with milking.

Warts sometimes disappear without treatment after a few months. If they are numerous, their disappearance will be hastened by twisting or clipping a few off, painting the spot with tincture of iodine and softening the remainder every three or four days with oil. Veterinarians sometimes use a vaccine prepared from wart tissue in obstinate cases.

Ketosis (Acetonemia)

Ketosis is one of the most serious disease problems confronting dairymen in this province. In many herds it causes heavy financial loss each year, particularly during the winter months, through lowered production, off flavoured milk and occasional deaths.

Ketosis is not always a separate disease but may occur as a complication. In these cases it would appear that the primary disease causes a drop in appetite which in turn brings on ketosis. Experimentally, it can be produced in a high yielding cow by starvation and no doubt some field cases are due to inadequate amounts of feed. However, many cases occur when no primary cause can be determined and it is generally assumed that a deficiency of some specific substance or substances is responsible. On some occasions cobalt deficiency has been associated with ketosis but this cannot account for all cases.

The condition is characterized by a high level of ketone bodies (fat breakdown products) and a low level of sugar in the blood. This indicates a switch from carbohydrates to fat as the principal source of energy for the cow and it appears to be the essential feature of the disease. This excessive burning of body fat causes rapid loss of condition and frequently this is the first symptom observed, along with partial loss of appetite and lowered milk production. A peculiar sweetish odor may be noted from the breath and the milk. A degree of constipation usually accompanies the condition. Severely affected cows may be dull and depressed although occasionally nervous symptoms such as licking the manger or fore legs, staggering or even convulsions have been observed. These nervous symptoms are definitely exceptions to the rule in Ontario.

In treating ketosis, practising veterinarians generally use glucose or other agents intravenously and most cases respond favourably within a day or so. Cortisone is reported to be an effective treatment but its scarcity and high cost make its use impractical except for very valuable cows. If a veterinarian is not available, a drench of Epsom salts (1 lb.) followed by a pound or more of sugar twice daily and a tablespoonful of cobalt solution (prepared by adding 1 ounce of cobalt sulfate to a gallon of water) once daily may bring about improvement in some cases. In addition, forced exercise, as provided by walking the cow for an hour or more each day, appears to be of benefit.

It is not possible at present to formulate a program of prevention which will be completely effective. However, the following points may assist in preventing the condition: (1) The practice of cutting off concentrates entirely for some days after calving is dangerous — energy should be supplied for current production. (2) Be sure that the ration is adequate in respect to both amount and composition. (3) Observe high producing cows closely since any slight upset may give rise to ketosis. (4) Daily exercise may help reduce the problem. (5) When ketosis is suspected, have the cow examined and treated promptly by your veterinarian.

Milk Fever

Milk fever is one of the most common diseases of dairy cows. It is not a fever — on the contrary, affected cows usually have an abnormally low temperature. It occurs most frequently within the first 48 hours after calving and is evidenced by a progressive paralysis leading to complete inability of the cow to get on her feet. This paralysis affects the throat making it difficult or impossible for the cow to swallow. *Do not drench a cow with milk fever* because her inability to swallow makes it probable that some of the material will reach her lungs and cause pneumonia. An affected cow usually shows a kink in her neck or will lay her head around on the flank. Breathing is labored and groaning is common. Untreated cases usually die.

Fortunately the treatment of milk fever through the intravenous use of calcium salts is generally successful. Treatment should be given as early as possible, preferably when the cow first shows symptoms of unsteadiness on her feet, but may bring about recovery at any stage. An alternative, also generally successful, is to inflate the udder with air. This practice, however is dangerous unless done with great care because of the risk of introducing mastitis germs.

Practical and dependable measures for the prevention of milk fever are lacking. The following are sometimes suggested;

1. *Feeding extra calcium.* Although cows with milk fever show a very low blood calcium level, feeding high levels of calcium before calving does not appear to be effective in preventing the condition.
2. *Injection of calcium salts intravenously or subcutaneously immediately after calving.* This will undoubtedly help prevent the condition but is hardly practical as a routine procedure. It is recommended in dealing with cows having a history of repeated attacks.
3. *Incomplete milking for two or three days after calving.* This may be of some value but it is dangerous if mastitis infection exists in the udder.

Bloat

The term bloat refers to an excessive accumulation of gas in the paunch. Bloating is a common symptom of digestive upsets and may be due to a variety of causes. It occurs in its most dangerous form among cattle grazing on lush pasture, particularly one that contains a high proportion of legumes, and under these conditions may cause heavy death loss. Not all legume pastures cause bloat and the reasons why some do are not completely understood. However, pastures either growing rapidly or wilted by drought after a period of rapid growth appear to be especially dangerous. A deficiency of soil phosphorus may also be a factor.

The relief of bloat may require the use of a stomach tube or operative procedures, in severe cases. An ounce of turpentine or a half-ounce of formalin shaken up in a pint of milk and given as a drench may be helpful in simple cases but drenching should be done slowly and carefully. Placing a gag in the mouth, standing the animal with the front quarters elevated and kneading the rumen with the fist all help to expel gas.

Recognition of the following points may be helpful in preventing pasture bloat:

1. Mixtures of grasses with legumes cause much less bloat than legumes alone. Practical tests show that serious bloat rarely occurs if grasses make up at least 50% of the mixture.
2. Supplemental feeding of hay in drylot at night will reduce the incidence of bloat on legume pasture. Feeding hay on pasture may also help.
3. Grass pasture at night will help prevent bloat on legume pasture the next day.

Vaccination cuts down losses from Brucellosis.

Abortion

Contagious abortion (brucellosis) is still widely distributed in Ontario although its effects are being countered by vaccination. Symptoms of infection include premature calving, retention of the afterbirth and subsequent sterility. Although the organisms usually localize in the udder or womb, on occasions they affect the joints, especially the knee and stifle. The site of infection in bulls is usually the genital organs.

A positive diagnosis of brucellosis in a breeding herd may best be established by having blood samples tested in a laboratory. While occasional early infections are missed by this test, it is in general a reliable method of determining whether or not the infection exists in a herd or in an individual animal.

This disease is frequently brought into clean herds by the introduction of one or more infected animals. It is spread within the herd by the discharges of infected cows contaminating pasture or foodstuffs of other cattle. An infected bull may also spread the disease at the time of service.

Most control programs are based on calfhood vaccination. Vaccination of calves from 6 to 8 months of age produces a serviceable immunity. The vaccination program is operated jointly by the Federal and Provincial governments and vaccination service can be obtained through practicing veterinarians.

It must be remembered that brucellosis is not the only cause of abortion in cattle. *Trichomoniasis* caused by a microscopic parasite, is spread by the bull at the time of service and causes abortion and sterility. Similar symptoms are produced by vibrio foetus infection. In both of these infections, abortions tend to occur at an early stage and may be missed by the owner. Where widespread sterility exists in a herd, along with occasional abortions, the condition should be thoroughly investigated since one or more of a number of causes may be operating.

Breeding Problems

Sterility or delayed breeding is a problem of increasing concern to dairymen. It is a complex problem arising from many causes and not, therefore, capable of quick solution. Like mastitis it is a continuing problem and requires a continuing program to combat it.

Suggested measures to improve breeding efficiency in the dairy herd are as follows:

1. Keep accurate and complete records of dates of heat, breeding, calving or abortion and unusual symptoms. Such records are of great value in arriving at a diagnosis in case of trouble.
2. Give cows a rest of at least 60 days after calving before breeding.
3. Do not breed a cow showing an unnatural discharge.
4. Isolate aborting cows until all discharge has ceased.
5. Consult a veterinarian if a cow does not conceive following three services to a fertile bull.
6. Owners of valuable breeding herds find it pays to have the breeding health of the herd checked at regular intervals by a qualified person. Regular pregnancy diagnosis is an important part of such a service.
7. Do not discard a cow because of sterility before having her examined for pregnancy.
8. If infertility is widespread in the herd be sure to check the herd sire.

Parasitic Diseases

The majority of cattle parasites in Ontario may be readily kept under control by sound farm management practices, proper sanitation and regularly applied preventive treatments.

The most serious parasites with which the dairyman has to contend are the warble flies and their grubs. These insects, if neglected, will cause loss of weight through making animals gad and their grubs may do extensive damage to carcasses and hides. The control of warbles, however, is well organized in the Province and is conducted on a community basis in many townships, which upon petition of two-thirds of the cattle owners, have passed by-laws requiring all cattle to be treated in accordance with the Warble Fly Control Act. In other areas, not under the Act, they are treated individually, as recommended in the regulations made under the Act. The hand dressing consists of one pound cube or derris powder containing 5% rotenone or its equivalent to one gallon of water. It is applied with a stiff brush to the backs of cattle in April and May.

"Barn itch" may unnecessarily cause unthriftiness in herds especially during the winter months. This condition is commonly caused by lice, at other times by ringworm or mange mites, either alone or collectively. Regular inspections of animals and routine use of standard dusting powders for lice, will keep herds free from these pests. Suspected cases of mange should be reported immediately to local representatives of the Health of Animals Branch, Canada Department of Agriculture, who will insure action is taken to prevent the spread of this disease.

Internal parasites (including worms coccidia and other protozoans) although they do become established in certain herds, are relatively unimportant in Ontario. High standards of sanitation, ample pastures, manger feeding and the use of properly constructed watering troughs will do much to keep disease caused by these parasites under control. Young animals, as far as possible, should be segregated from older stock.

Disinfection

The contamination of bedding, floors, stalls and yards by the discharges of infected animals is the principal means by which an infectious disease is spread.

To destroy infection, all bedding and manure accumulating from sick animals should be burned or spread thinly on ground to which other animals do not have access. Stalls and floors should be thoroughly cleaned and disinfected.

Chemical Disinfectants

Lye — 1 pound to 20 to 30 gallons of boiling water.
Creolin — 2% solution.
Liquor cresol compound U.S.P. — 2 to 3% solution.
Carbolic acid — 3 to 5% solution.
Bichloride of mercury — 1 part to 1,000 parts of water by weight.

Other disinfectants — use according to manufacturers' directions.

As a rule chemical disinfectants are more effective when used hot. This is especially true of lye which is a cheap and effective disinfectant against most disease organisms.

SOLUTIONS	IN 1 QUART OF WATER	IN 1 GALLON OF WATER
2% solution	6 teaspoons	3 ounces
3% solution	2½ tablespoons	4½ ounces
4% solution	3 tablespoons	6 ounces
5% solution	3½ tablespoons	7 ounces

Horn Fly Control on Cattle

Horn flies are the most common pests on cattle during the summer. These are small, dark, gray flies about half the size of house flies. They always rest on cattle with the head down and are most numerous over the withers.

These small flies breed in fresh cow manure but not in manure piles. The adults do not leave the cows except when they are laying eggs. Thus, to obtain control of this species, cattle themselves must be treated.

Control

DDT and certain other insecticides leave a residue in the fat and milk of cattle which have come in contact with the insecticide. This can result from the cattle being sprayed or by feeding from mangers or drinking from water troughs which have accidently been sprayed and may contain small quantities of the insecticide. Such residues in human food, especially those of DDT, must be considered as hazardous to the health of man. Therefore, insecticides which will leave a hazardous residue must not be used on dairy cattle at any time or on beef cattle within three months of slaughter. Chlordane should never be applied to cattle.

Methoxychlor, piperonyl butoxide and pyrethrum, thiocyanates, and certain other mixtures are not regarded as hazardous and may be used on cattle where DDT is prohibited.

Recommendations for Treatment

(1) METHOXYCHLOR – Available as a 50% wettable powder.

Power Spraying –

Methoxychlor 50% wettable powder	1 lb.
Water	12 gal.

Apply approximately ½ gallon per animal using about 250 lbs. pressure.

Hand Spraying – Wheelbarrow, knapsack, or compressed air sprayer.

Methoxychlor 50% wettable powder	1 lb.
Water	12 gal.

Wet animals as thoroughly as possible.

NOTE: Methoxychlor should give up to three weeks' protection.

(2) PIPERONYL BUTOXIDE – PYRETHRUM, THIOCYANATES and other mixtures.

These are available in oil-base commercial preparations and should be used according to manufacturer's directions. Such oil-base mixtures are not suitable for power spraying. They should be used only in small atomizing sprayers and should be applied as a mist over the animals or on the outer hair only. Animals must not be soaked with any oil-base spray. These insecticides, although not possessing the lasting effects of methoxychlor, do give a quick knock-down of flies followed by only a brief period of protection.

Certain commercial mixtures of this type (but not oil-base) may be available for power spraying.

House Fly Control in Stables

The control of houseflies in stables in many instances has proved difficult. In experimental work at the O.A.C. in 1950 satisfactory control was still obtained with DDT. While lack of control may in some cases be due to resistant strains of flies other important factors cannot be ignored. Lack of sanitation (too many breeding places), insufficient concentration and inadequate application of DDT spray must be considered. With regard to the latter it should be pointed out that if the spray is too dilute or inadequately applied the flies do not receive enough insecticide to kill them and thereby develop resistance.

However, where a particular insecticide does not give satisfactory control another should be used. Alternative sprays are listed below.

Control

(a) SANITATION

Destroy the breeding places, where farm operations permit, manure should be hauled out once a week or oftener and spread on the land. Haul out fresh manure first. Barn sprays are good but breeding must be reduced. Manure piles must *not* be sprayed with an insecticide since this tends to develop resistance more rapidly and to a higher degree.

(b) SCREENS

Milk houses should be screened, and stables and piggeries also if practicable.

(c) CHEMICAL CONTROL

In all chemical control great care should be exercised to keep the insecticide from contaminating mangers, feed bins, water troughs, feed or any place that the cattle may lick. The insecticide should be applied as a coarse wetting spray to the walls and ceiling, about windows and doors, where the flies rest.

Insecticides may be applied by a *power sprayer* under very low pressure or by a *hand sprayer* of the wheelbarrow, knapsack, or two to three gallon compressed air type. A large white wash brush may be used if a sprayer is not available. In all cases the walls must be wet to the run-off point. Fog or mist sprayers or aerosol types should not be used with the materials listed below.

(1) DDT

POWER SPRAYING AND HAND SPRAYING	
DDT 50% Wettable Powder	1 lb.
Water	5 gal.

If the machine will handle a higher concentration in hand spraying such may be used. For brush use 1 lb. DDT 50% wettable powder to 2 gal. of water or use the 5% DDT in oil spray as purchased.

(2) LINDANE

POWER SPRAYING AND HAND SPRAYING	
Lindane 25% Wettable Powder	1 lb.
Water	5 gal.

(3) METHOXYCHLOR

POWER SPRAYING AND HAND SPRAYING	
Methoxychlor 50% Wettable Powder	1 lb.
Water	5 gal.

Emulsions of the above materials may be available. These will give satisfactory results if used in accordance with directions on the label.

Caution — the operator should exercise care in handling these materials. Read the label on the container carefully.

NOTE:—These recommendations have been prepared in cooperation with the Division of Entomology, Canada Department of Agriculture.

Single storey milking shelter dairy barn with attached feed storage.

HOUSING THE DAIRY HERD

The proper housing of the dairy herd is an important feature of the sanitary, environmental, and comfort aspects necessary for increased production.

Dairy Barn Types

Two types of dairy barn systems, the stall and loose housing, are now being used in Ontario, and each has merit.

The stall barn is the more common type in Ontario. In this type all the milking cows are housed in the barn at one time and usually a separate stall is provided for each cow. Since many years of practical experience has developed this system and because the dairyman has become accustomed to it, continued use can be expected.

The loose housing system of housing dairy cattle is relatively new. The proper layout consists of five specialized areas — the resting area, feeding area, paved yard, milking area and specialized pen area. Research and practical experience indicates that the animals do well under this type of housing. This system results in the production of a high quality milk, provides a low cost type of structure, and makes possible an assembly line technique in milking.

Materials of Construction

The design of suitable housing for a dairy herd requires careful consideration of the construction materials, for herein lies much of the economy of a new or a remodelled structure. Some of the characteristics of good building materials are sanitation, durability, strength, fire resisting qualities, and thermal characteristics. The general trend in dairy structures is toward light masonry units and light structural framing and this is made possible by using many of the new building materials that are of light construction yet strong and durable.

Conventional type two-storey barn with farm house and farm buildings.

The initial costs and the maintenance costs are of prime importance in constructing dairy buildings and these are largely determined by the materials used in construction. Concrete is one of the better materials since it has a low maintenance cost, is workable in its initial state, is durable, and above all is sanitary.

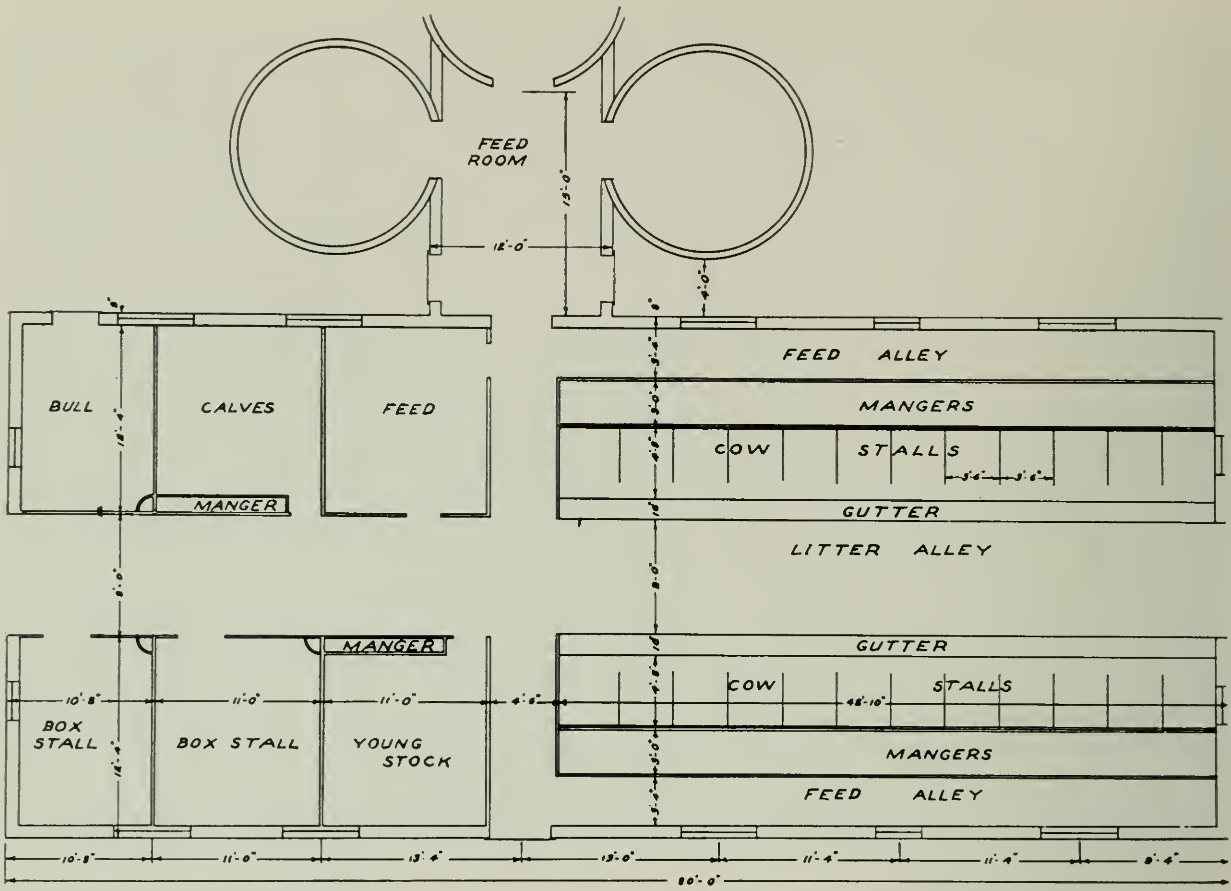
Types of Stall Barns

There are several types and combinations of types of stall barns. Present trends indicate an increased interest in one-storey barns, due in part to the increased use of baled or chopped hay and grass silage. Frequently the old barn can be used for housing the young stock and dry cows, as well as providing storage for roughage and bedding. A new modern dairy barn of one-storey construction may cost little more than remodelling the old barn.

The two-storey structure must have a frame strong enough to carry the weight of a winter supply of hay, grain and bedding for the herd, as well as the loads imposed by wind and snow. Many variations are possible in detailed arrangements but basic design and dimensions have become almost standard. By building the two-storey structure, requiring one foundation and one roof, economies in building costs and labour are secured which are hard to obtain in one-storey construction.

PLANNING THE STALL BARN

A well planned and properly constructed barn saves labour, makes for pleasant working conditions, prevents waste of feed, increases milk production and adds to the comfort of the animals. In planning a dairy barn, there are a number of factors which require special consideration, including sanitation, animal comfort, stall arrangements, stall, manger, and gutter dimensions.



A plan of a typical dairy barn with face-out arrangement. This arrangement allows efficient work behind the cows. The walls are not spattered with droppings, fewer doors are required, mangers are exposed to direct light and more efficient use is made of space for pens, box stalls and feed.

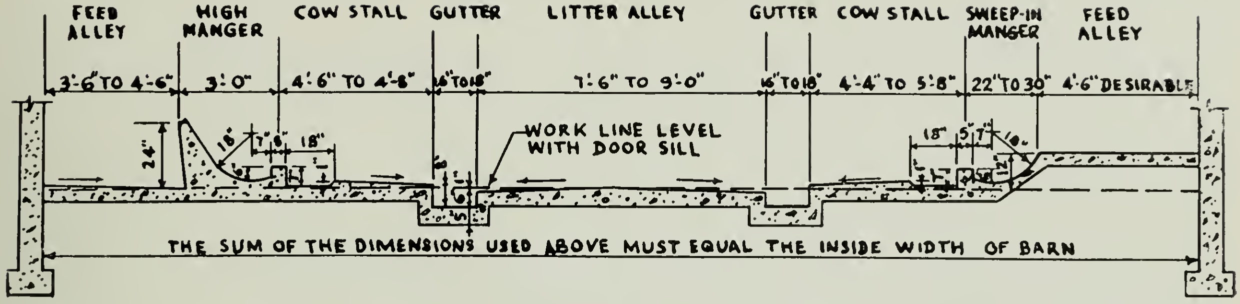
Table No. 11. Stall Dimensions

Weight of Cow	Girth in Inches	Width of Stall	—Length of Stall—
800 lbs.	65	3'4"	4'6"
1000 lbs.	70½	3'8"	4'8"
1200 lbs.	75	4'0"	5'0"
1400 lbs.	79½	4'4"	5'4"
1600 lbs.	84+	4'8"	5'8"

Manger Dimensions

There are two types of mangers — high back and low or sweep-in type. The floor of the manger is raised so the cow feeds from a height of one or two inches above the standing platform. The curb in front of the cow is 6 to 8 inches high, while the front of the manger may be flush with the floor for the sweep-in type, or be raised 24 inches above it for the high front type. The continuous manger should drain to one end to facilitate cleaning and have a slope of one-half inch in twenty feet.

Gutter Dimensions



A section view of face-out arrangement showing recommended dimensions. On the right is shown construction of sweep in manger while on the left is the high manger.

Daylight, Doors and Windows

It is recommended that at least four square feet of window glass area per cow be incorporated in buildings, with three square feet being acceptable in the northern areas. For glass block in place of window; provide 6 square feet of glass area per cow. Sliding doors are generally recommended for dairy barns with double sliding doors for drive-through central litter alley. Door openings should be 8 feet wide and at least 6 feet 6 inches high.

Feed Storage

TABLE NO. 12. UNIT WEIGHT OF MATERIALS

Material	Weight per cu. ft.
Grains, bulk	lbs.
Barley	39
Corn, shelled	45
Oats	26
Rice	36
Rye	45
Soybeans	48
Wheat	48
Feed, concentrates	
Bran	13
Grains and Supplement mixed	32
Linseed or Soybean meal	30-40
Middlings, loose	25
Feed, roughage	
Hay, bales, loose bales	10
Ordinary bales	12-14
Hay chopped	8-10
Hay long	4-5
Silage	33-50

Approximate tonnage capacities of round silos from top of silo to various depths and average weight per cubic foot of silage.

TABLE NO. 13.

Depth of Settled Silage (in ft.)	Diameter of Silo						Average Weight of Silage per cu. ft. lb.[*]
	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.	
	Tons	Tons	Tons	Tons	Tons	Tons	
10	15	22	29	38	49	60	38
15	25	35	48	63	80	99	42
20	35	50	68	89	113	139	44
25	45	65	89	116	147	181	46
30	56	80	110	143	181	224	47
40	....	....	152	198	251	310	51
45	....	....	....	226	286	353	52
50	....	....	....	....	320	396	53

[*] Average weight in lb. per cu. ft. for all silage above depth indicated.

Ventilation

Adequate ventilation provides a suitable atmosphere within the dairy barn, maintains the health and production of the herd.

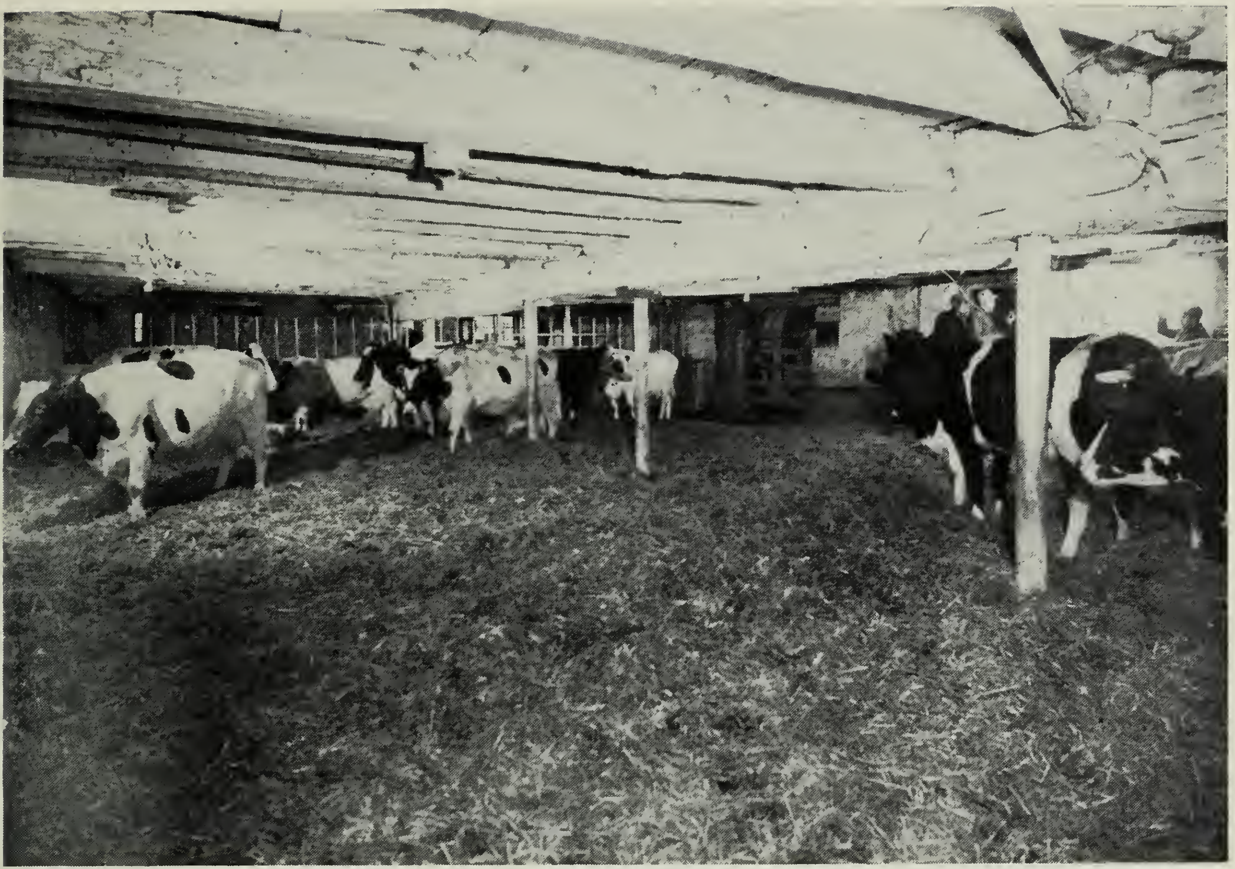
Ventilation should –

1. Keep the stable dry.
2. Remove stale air and strong odors.
3. Bring in fresh air without draughts and without making the stable cold.
4. Remove excess heat during the warm spells and maintain a near uniform stable temperature.
5. Draw off excess moisture and thus prevent the deterioration of woodwork, the peeling of the paint and the corrosion of metal parts and electrical fixtures.

Amount of Ventilation Required

The dairy cow gives off considerable body heat which is utilized to keep the stable warm. A stable temperature between 45° F and 55° F with a relative humidity of 75% is the best for the comfort and health of the animals. With outside temperatures below 0° F it requires 25 to 30 cubic feet of air per minute for each 1,000 pound cow to maintain correct stable temperature and humidity. At temperatures between 0° F and 32° F, 40 to 60 cubic feet per minute is required while for temperatures above freezing, 60 to 120 cubic feet per minute is needed.

Since the outside temperature is constantly changing over a wide range a varying volume of air is required to maintain a satisfactory condition within the dairy stable. An exhaust fan, or fans, properly installed and properly located



Loose housing system. A low cost type of structure in which chore time is reduced and healthy cattle maintained.

and equipped with a thermostatic control, will maintain a uniform temperature within the stable.

TABLE No. 14. FAN CAPACITY

No. of Animal Units	—Air Required in C.F.M.—		No. of Fans	No. of Thermostats	Size of Fans
	Cold Weather	Weather Warm			
20	600	2000	1	1	600 & 2000 c.f.m. (T)
30	900	3000	1	1	900 & 3000 c.f.m. (T)
40	1200	4000	2	1	1 – 1200 c.f.m. (C) 1 – 2800 c.f.m. (T)
50	1500	5000	2	1	1 – 1500 c.f.m. (C) 1 – 3500 c.f.m. (T)
60	1800	6000	2	1	1 – 1800 c.f.m. (C) 1 – 4200 c.f.m. (T)
90	3000	9000	3	1 or 2	1 – 3000 c.f.m. (C) 1 – 3000 c.f.m. (T)

Animal Unit is a 1000 lb cow or its equivalent
(C.F.M.) cubic feet per minute
(T) Fan on Thermostat Control
(C) Fan on continuous operation.

PLANNING THE LOOSE HOUSING SYSTEM

The single storey self-feeding type of structure and the remodelled stall barn are two types of construction which are specifically designed for loose housing. However, almost any type can be converted to this system provided the building adheres to certain principles. The building can be uninsulated and should have a housing area of 50 to 60 square feet per cow which does not include the requirement for the feeding area space. The ceiling clearance should be at least 9 to 10 feet to allow the manure pack to build up and the building should be a fairly sound structure. Concrete or masonry walls should be at least 4 feet high.

The pole barn is one type of single storey structure used for loose housing systems and is so-called because of its pole framework. The essential features are the low cost and versatility of the structure. The remodelling of conventional barns to loose housing is the more common in Ontario because of the desire to use existing buildings.

Planning the Loose Housing Barn

The loose housing barn is divided into five distinct areas, each having an important function in the system.

The Resting Area

In the resting area or loafing area the cattle are free to move about and bed down on the pack which is warm and comfortable. Bedding requirements are about 12 pounds of straw per cow per day. Shavings and sawdust can be used but the requirement per cow is almost double that of straw.

Feeding Area

Allow 25 to 35 square feet per cow not including the space required by silage bunks or feed racks. If a combined resting and feeding area is used, allow a total of 75 to 95 square feet per cow. Where feed is stored overhead self feeders can be used and where silage is fed in separate feed bunks, allow 28 inches of length per cow.

Provide an adequate supply of clean, fresh water and make some provision to prevent it from freezing.

Exercise Yard

An exercise yard should be provided outside the bedded area with 50-75 square feet per cow or if unpaved yard 300 square feet per cow. Allow at least one inch slope in 10 feet for proper drainage.

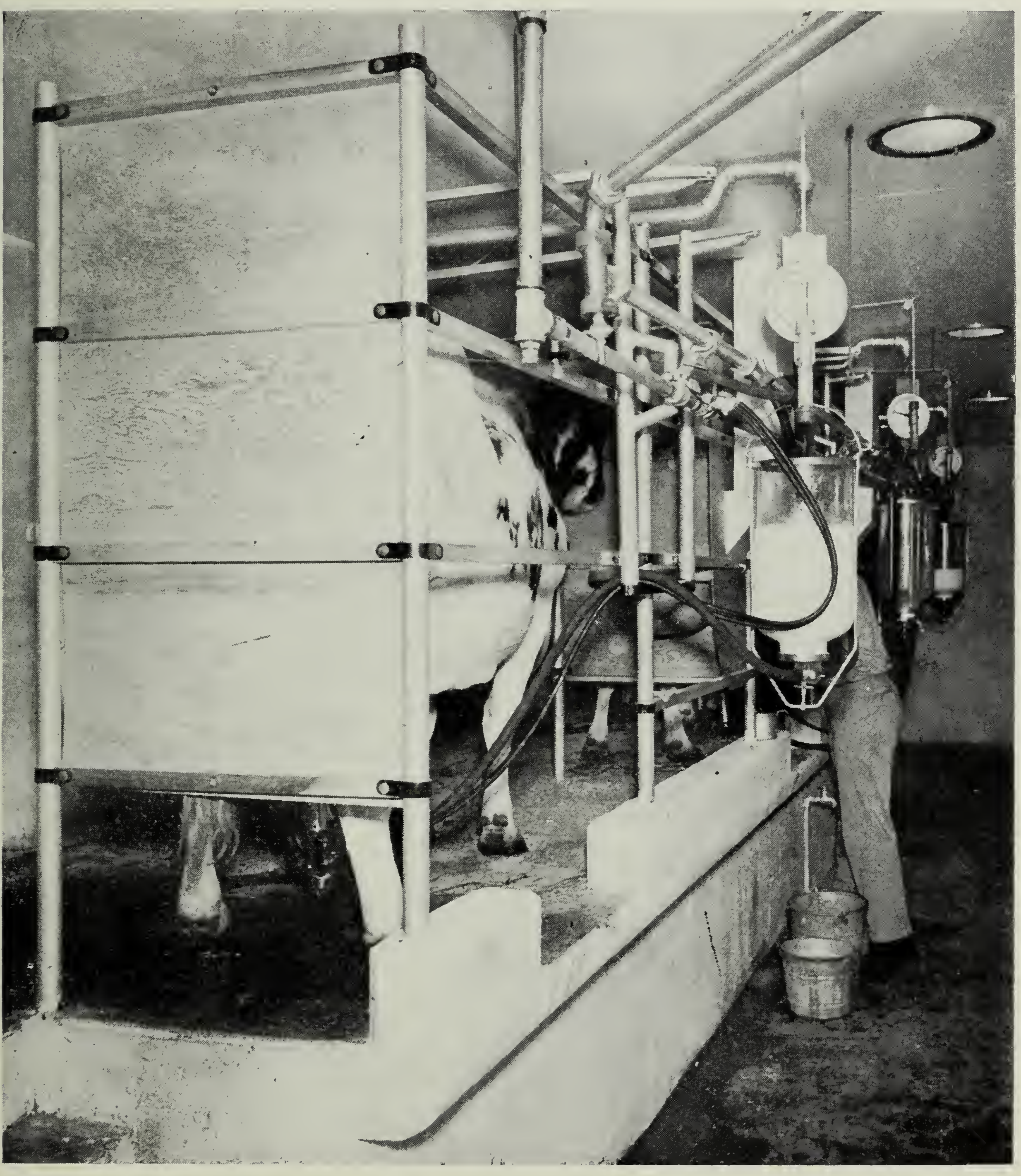
Milk Area

The principle feature of the loose housing system is the milking room which enables one or two operators to handle several cows in relays.

The following recommendations are given:—

1. Locate the milking room so that the doors will open into the resting and feeding areas or into holding pens. This keeps the milked and unmilked cows separate at milking time.

2. Elevate the milking room stalls to a height of 34 inches above the floor to permit the worker to work without stooping.
3. Use mechanical means for opening doors where possible.
4. Install several 6-inch drains to permit easy cleaning.
5. Insulate the milking room so it can be heated economically.
6. Locate the milking room and milkhouse in such a manner that the traffic is cut to a minimum.
7. Arrange the milking room stalls for maximum efficiency. Three to five minutes should be adequate milking time per cow.



A modern milking parlor, clean, sanitary, with comfortable working conditions. This milking parlor is located at the Ontario Agricultural College, Guelph, Ontario.

Special Areas

While some dairymen permit young stock and dry cows to run with the milking herd, the usual recommendations are to provide separate pens for these animals. Maternity pens may be formed with the use of temporary gates in the bedded area. The pens should be approximately 10 feet by 10 feet.

Calf pens should be close to the milking room to facilitate feeding and watering and should provide 20 square feet of pen space per calf. A separate resting and feeding area may be provided for young stock, close to the cows if possible, to reduce the distance travelled in doing chores, or in a separate shed close to the feed supply. Allow about 30 to 50 square feet of pen space per head.

The committee wishes to acknowledge the co-operation given by the Department of Public Relations, Photographic Division, Ontario Agricultural College, Guelph, in securing many of the illustrations in this bulletin.

BULLETIN 494 SEPTEMBER, 1952

NUT CULTURE IN ONTARIO

•

HORTICULTURAL EXPERIMENT STATION
VINELAND STATION, ONTARIO

Variety nut plantation, Horticultural Experiment Station. Filberts beginning to leaf out, walnuts barely showing new spring growth.

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

The culture of nuts in Ontario, while not commercially attractive, is of interest to many people. This interest, stimulated in recent years by enthusiastic publicity, is due in part to the value of nut trees as ornamentals, and in part to the possibilities of actual production of nuts for home use.

This bulletin indicates the present status of nut growing in Ontario, outlines cultural methods, and examines limiting factors such as climate, soil, and pollination. Species and varieties and their propagation are discussed in some detail.

At present, nut culture cannot be considered an attractive commercial venture in Ontario, and the individual who may be contemplating extensive planting should proceed with caution. Present varieties are not sufficiently dependable either as to hardiness or yield.

The amateur nut-grower can do much to further our knowledge of nut growing and demonstrate the possibilities under Ontario conditions. He can plant the kinds and varieties that appeal to him without regard to monetary profit. Partial or even complete failure of this or that variety will not be disastrous, and will contribute useful information.

Eventually, a commercial industry may be built on the introduction of varieties better adapted to our climatic conditions. The enthusiastic amateur provides the testing ground for such material.

CONTENTS

PAGE

Introduction - - - - - - - - - - 5
Nut Culture in the Northwestern States and Ontario - - - 6
  Northern Nut Growers Association (NNGA) - - - - - 6
  Individual Workers with Nuts - - - - - - 6
  State Institutions—Experiment Stations and Colleges - - 7
  Ontario Horticultural Experiment Station - - - - 7
Climatic Considerations - - - - - - - - 9
  Summer and Winter Temperatures - - - - - 9
  The Growing Season - - - - - - - - 10
  Weather Records of Southern Ontario - - - - - 10
Classes and Varieties of Nuts - - - - - - - 11
  Butternut *(Juglans cinerea)* - - - - - - 11
  Black Walnut *(Juglans nigra)* - - - - - - 11
    Varieties of Black Walnut - - - - - - 11
  Persian Walnut *(Juglans regia)* - - - - - - 11
    Varieties of Persian Walnut - - - - - 13
  Japanese Walnut *(Juglans sieboldiana)* - - - - 13
  Shagbark Hickory *(Carya ovata)* - - - - - 15
  Pecan *(Carya olivaeformis)* - - - - - - 15
  American Sweet Chestnut *(Castanea dentata)* - - - 15
  Chinese Chestnut *(Castanea mollissima)* - - - - 15
  Japanese Chestnut *(Castanea crenata)* - - - - 15
  European Chestnut *(Castanea sativa)* - - - - - 15
  American Hazel *(Corylus americana)* - - - - - 17
    Varieties of American Hazel - - - - - 17
  European Filberts *(Corylus avellana)* - - - - 17
    Varieties of European Filberts - - - - - 17
Sites and Soils - - - - - - - - - - 18
Pollination - - - - - - - - - - 19
Propagation - - - - - - - - - - 20
  Seed - - - - - - - - - - - 20
  Layering - - - - - - - - - - 21
  Budding and Grafting - - - - - - - - 21
Planting - - - - - - - - - - - 22
Pruning - - - - - - - - - - - 23
Tillage, Mulching, Fertilizers - - - - - - - 23
Harvesting - - - - - - - - - - - 24
Yields - - - - - - - - - - - - 24
Pests - - - - - - - - - - - - 24
Acknowledgments - - - - - - - - - 25

NUT CULTURE IN ONTARIO

W. J. STRONG

Tree nuts have been a staple food in parts of Europe and Asia for many years. In the time of the Romans they were greatly appreciated, and even earlier than that they were used by the peoples of the Orient, notably the Chinese and Japanese.

While nuts may not be considered a staple food on the North American continent they are used in large quantities on special occasions, particularly Thanksgiving and Christmas, and by the confectionery business. They are a highly concentrated food, walnuts, pecans, filberts and hickories being rich in oils and proteins, while chestnuts are high in carbohydrates (starches).

The growing of nut trees in Ontario has not been developed to any great extent, due perhaps to the failure of the available kinds to produce a paying crop of nuts. Several species are native to the warmer parts of the province. Most of these, however, are very close to the northern fringe of their natural range. The butternut *(Juglans cinerea)* and the native hazel *(Corylus americana)* are, of course, exceptions, as they are much more widely distributed. Persian walnuts *(Juglans regia)* and filberts *(Corylus avellana)* from Western Europe, have been planted in a small way for a good many years but, generally speaking, results have been disappointing. Lack of hardiness and uncertainty of yields would seem to be two of the main causes. The so-called Carpathian Persian walnuts from Eastern Europe appear to be hardier than others and may eventually fill a long-felt need.

According to a California publication*, almonds are the most important tree nut, amounting to 29 per cent of the world production. Persian walnuts are second, accounting for 25 per cent, filberts come third with 21 per cent, Brazil nuts fourth with 7 per cent. No figures are given for chestnuts. The United States, France, and Italy are the main producers of Persian walnuts, almonds, pecans, and filberts.

Almost 200,000 tons** of nuts in the shell were produced in the United States in 1951. Of this quantity California produced 90 per cent and Oregon about 10 per cent of the walnuts (72,000 tons), the Southern States practically all of the pecans (75,000 tons), and the Pacific Northwest most of the filberts (8,400 tons). California also produced about 39,500 tons of almonds.

The bearing acreage of walnuts in California was about 113,000 in 1947; of which 54,000 acres were in the south and 59,000 in the north. The tendency seems to be for increased plantings in the north while, in the south, plantings are decreasing. In some cases trees are being uprooted as being unprofitable due to pest infestation and disease, and to some extent at least, to suburban development. Walnuts apparently are not a good enough paying crop to be grown where insect pests and diseases are prevalent, nor on high-priced land.

Canadian commercial production of nuts is limited to a few small plantations of filberts in the milder parts of the Pacific Coast of British Columbia.

---

*The Walnut Situation 1948. Circ. 386 California Agr. Exp. Station.
**Science News Letter, Feb. 16, 1952. Vol. 61, No. 7.

NUT CULTURE IN THE NORTHEASTERN STATES AND ONTARIO

Nut culture has been much slower developing in the Northeastern States and in Ontario than it has been in the Southern States and on the Pacific Coast. The main reason for this, no doubt, has been the lack of suitable varieties. Most of those brought from earliest times from Europe were not well adapted to our climatic conditions and so did not become established. It is true that a good many individual trees of Persian walnuts and filberts are to be found growing in the northeastern part of the continent, including Ontario, but no large commercial nut industry exists. Of course, butternuts, black walnuts, hickories and, until recently, chestnuts, have been gathered from the wild trees and sold in large quantities.

Various attempts have been made to stimulate interest in nut growing in the Northeast. Back in 1896 Andrew Fuller of Ridgewood, New Jersey, published his book, The Nut Culturist, and since then several books and numerous bulletins have been published.

Northern Nut Growers Association (NNGA)

In 1910 a group of men including Dr. N. L. Britton, Director of the New York Botanic Garden; Professor John Craig, of Cornell University; Dr. R. T. Morris, of New York City (author of the book, Nut Growing); Dr. W. C. Deming, now of Hartford, Conn. (the first secretary of the Association); Mr. T. P. Littlepage, of Washington, D.C., and Professor C. P. Close, were instrumental in organizing the Northern Nut Growers' Association. This Association started out with a membership of 60, and by 1950 had approximately 500 members. The purpose of this organization is to promote interest in nut growing and to disseminate information. Meetings are held annually and many papers are presented on various aspects of nut growing, later published as an annual report.

The Association* has issued a circular which outlines its activities and states the advantages of membership. It lists almost two dozen bulletins and books on nut culture, prepared by government institutions and individuals. Also, it gives the names and addresses of 38 nurseries and individuals who propagate nut trees commercially.

Individual Workers With Nuts

Many individuals contributed, and others are still contributing, through experimental work, to our knowledge of nut culture. One hundred and two members of the NNGA are listed in an appendix of the 40th Annual Report of the Association, as being actively engaged in nut experimental work.

Among Canadian workers must be mentioned the late Professor J. A. Neilson, who did much to promote interest in nut growing and who also discovered a number of worthwhile nut trees in various parts of Ontario. Probably the late Geo. H. Corsan, of Islington, Ont., has done more than anyone in this province to publicize the idea of growing nuts. He brought together many types of nuts on his property, "Echo Valley", just west of Toronto and, in season and out, proclaimed the value of nuts. He was also an adept propagator as many will attest who have seen his grafted trees.

Another Canadian who was much interested in growing nuts was the late Sir William Mulock who had several acres of black walnuts growing on his estate near Newmarket. For many years Mr. Alex Troup of Jordan

---

*The present (1952) secretary of the NNGA is Mr. J. C. McDaniel, 104 Horticultural Field Laboratory, Urbana, Illinois.

Station, has grown nuts including black walnuts, Persian walnuts, Japanese heartnuts, chestnuts, filberts and pecans. Among others who have planted nut trees are Mr. O. Filman, of Aldershot, the Papple Bros. of Cainsville and Mr. Levi Housser, of Beamsville.

Perhaps one of the most noteworthy contributions to nut growing in the colder parts of North America was the introduction of the Carpathian form of the Persian walnut from the Carpathian mountain region of the Ukraine and Poland, by Rev. Paul C. Crath of Toronto. Mr. Crath, a native of the Western Ukraine, came to make his home in Ontario in 1917, and very soon afterwards made arrangements for some of these nuts to be collected and shipped to Ontario. He made several trips back to the Ukraine and explored parts of the Carpathian mountains in his hunt for good walnuts.

As a result of Mr. Crath's activities many of these walnuts were brought into Ontario and the United States. They were distributed widely, and many hundreds of seedlings are now bearing nuts. It remains for those who have these trees to take good care of them and keep careful records of their performance, so that promising seedlings may be discovered and propagated by budding or grafting. It is hardly likely that any more of these nuts can be obtained from the Ukraine or Poland under present conditions.

Another nut worker who should be mentioned here is Mr. J. U. Gellatly of Westbank, B.C. He has been operating a nut nursery for many years and has contributed much to our knowledge of nut growing.

State Institutions—Experiment Stations and Colleges

Several state institutions are working on some of the phases of nut culture, including the introduction of different sorts from other countries, variety testing, breeding for disease resistance (chestnut blight), propagation, cultural problems, and pest control. Breeding for resistance to chestnut blight may have the most far-reaching results of any nut work so far undertaken, as it can mean the re-habilitation of the chestnut forests of Eastern North America.

Ontario Horticultural Experiment Station

In 1914 a few filberts and Persian walnuts were planted at this Station, and since then, from time to time, more filberts and Persian walnuts (including the Carpathian strain) have been added; also chestnuts, black walnuts, Japanese walnuts, hickories, pecans and several hybrids.

Named varieties and hybrids grown at the Horticultural Experiment Station are listed below:

Black Walnuts
(Juglans nigra)
Eldrige x
Learn x
McCoy
Ohio
Snyder x
Sparrow x
Stabler
Ten Eyck
Thomas
Troup x

Persian (English) Walnuts
(Juglans regia)
Alpine
Franquette
Hall
Littlepage x
Mayette
McDermid
Rush
47 Carpathian
Sdlgs. (Corsan)

Chinese Chestnuts
(Castanea mollissima)
Keeling
Meiling
Nanking
U.S.D.A. 6 seedlings
N.J. Exp. Sta. 8 seedlings

Hickories
(Carya ovata)
Anthony x
Fox x
Goheen x
Minnie x
Wilcox x

x Young non-bearing trees, 1952.

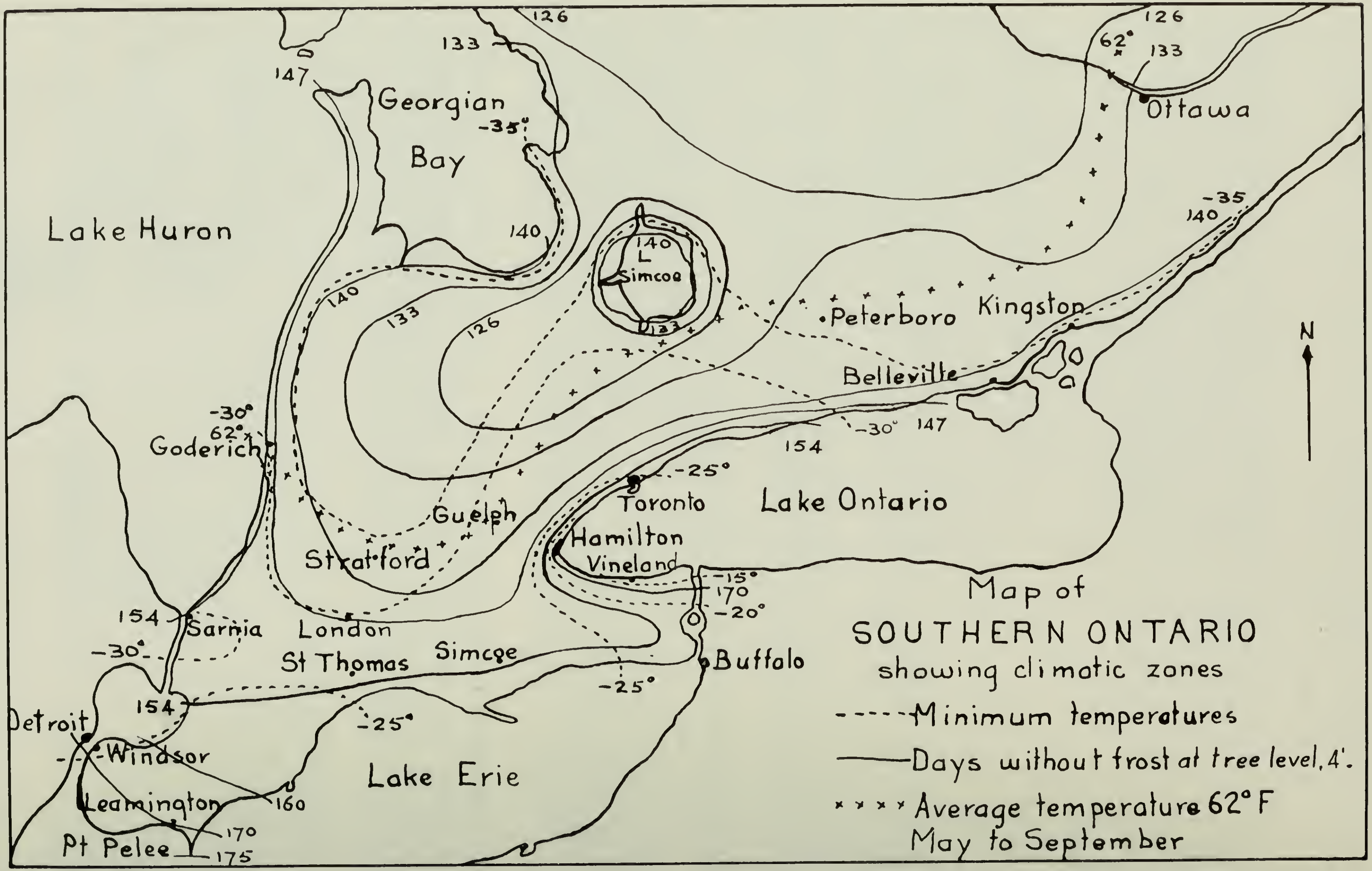


Fig. 1. This "climatic" map of southern Ontario should be studied in relation to the text, Climatic Considerations, pages 9 and 10.

Filberts
(Corylus avellana)

Barcelona
Beethe
Bixby (hybrid)
Bolwyller
Buchanan (hybrid)
Cosford
Daviana
Du Chilly
Jones (hybrid)
Luisen
Medium Long
Volkugel
White Aveline

Hazel x filbert hybrids — N.Y. State Exp. Stn.

Geneva 21—(Rush* x White Aveline)
" 110—(Rush x Du Chilly)
" 111— " " " "
" 157—(Rush x Barcelona)
" 159— " " "
" 200—(Rush x Bolwyller)
" 394—(Rush x Red Lambert)
" 398— " " " "
" 485—(Rush x Du Chilly)
" 555— " " " "
" 529—(Rush x Daviana)
" 531— " " "

*A selection of *C. americana*

A fairly detailed report on the behaviour of many of these nuts was given at the meeting of the NNGA held in Guelph in 1947 and is included in the 38th Annual Report of the Association. Material from this report, with further added data, appears on pages 11 to 18 of this bulletin.

The nut work carried on at the Horticultural Experiment Station has been almost entirely testing of varieties and seedlings, with some attempts at grafting and budding.

CLIMATIC CONSIDERATIONS

Climate is often the deciding factor in the successful growing of fruit trees, and it is no less a factor in the growing of nut trees. Some nuts, like the native hazels and butternuts, are much better adapted to the climate of Ontario than the Persian walnut or the European filbert for example. Some kinds are not hardy to low, winter temperatures. Wood may be injured or catkins (pollen-bearing flowers) frozen. Others need a long growing season, and a high total of summer heat units. It must be remembered too, that climatic conditions vary considerably from year to year. Thus, in a certain locality, the minimum temperature may be zero or a few degrees below in most winters, but occasionally, in what may be called a test winter, the temperature may drop to —15°F. or —20°F. Again, the length of frost-free period at tree level (4 ft.) may be perhaps 150 days in one year while in another it may be 170 days or more; and too, total summer heat will vary from year to year. Hence, before planting nut trees in a given locality, it is important to study its climatic conditions and the variations that are likely to occur over a period of years.

Summer and Winter Temperatures

A winter temperature of —20°F. is critical for pecans, Persian walnuts and filberts. Within these species, however, there are strains and varieties which vary greatly in hardiness, and this fact must be considered when choosing those to plant.

It has been determined that the average temperature for the growing season should be at least 62°F. This applies to most species of nut trees with the possible exception of butternuts and filberts which apparently do not need quite so high an average temperature. Pecans, on the other hand, require a considerably higher average than 62°F.

The Growing Season

A common difficulty with nuts, especially walnuts, in Ontario is that the kernels fail to mature properly. A severe early freeze in the fall will defoliate the trees and stop development of the nuts. Again, in some seasons, with no early freeze, the nuts may be full size and appear to be normal but may have shrunken kernels.

Too little summer heat and too short a growing season are the most frequent causes of shrunken kernels or poorly filled nuts. Development of the kernel stops with leaf fall, whatever the cause. Little or nothing can be done to remedy this situation other than to grow early maturing varieties. In fact, unless there is a frost-free period of 150 days it is impossible to produce high-quality nuts. This is especially true with pecans, Persian walnuts, filberts, and hickories. The trees of these species are usually hardy enough to withstand the *average winter* in the milder parts of Southern Ontario but require a longer growing-season than that prevailing in most parts of the province.

Severe drought is sometimes the cause of nuts failing to fill. However, a dry, sunny season will produce better-filled nuts than a cool, moist one.

Weather Records of Southern Ontario

Weather records show that the areas in Ontario which satisfy the above conditions are limited (see map, page 8).

Two areas have minimum temperatures that do not go below —20°F. One is a narrow strip bordering the north shore of Lake Ontario from near Oakville to Hamilton; thence the Niagara District below the escarpment and east to the Niagara River. In the Niagara District the minimum temperature seldom falls below —15°F. The other section where the temperature rarely if ever drops below —20°F. is in Essex County, adjacent to Harrow and Leamington.

Outside of these two small areas, in the counties bordering Lakes Erie and Ontario, temperatures of —25°F. and —30°F. sometimes occur; and back farther from these lakes and at greater elevations, still lower temperatures may be experienced.

Length of frost-free period varies greatly with locality. In Algonquin Park it may be only 90 days, while in the mildest parts of Ontario, already mentioned, it may average 170 to 180 days. The minimum of 150 days without frost is limited to the area bordering the southern part of Lake Huron, to the counties adjoining Lakes St. Clair and Erie, and to a narrow strip from Niagara Falls around the western end of Lake Ontario to some distance east of Toronto.

The area having an average temperature of 62°F. from May to September inclusive, is not clearly defined. The line of demarkation, however, appears to run from a point on Lake Huron just above Goderich, across to the Ottawa river, a few miles west of the city of Ottawa. Roughly, this is 50 to 60 miles back from Lake Erie, and 30 to 40 miles back from Lake Ontario.

CLASSES AND VARIETIES OF NUTS

The main groups of nuts likely to be of interest in Ontario are the walnuts *(Juglans)*, hickories *(Carya)*, chestnuts *(Castanea)*, and filberts *(Corylus)*.

Butternut *(Juglans cinerea)*

The butternut is found growing wild from the St. John River in Southwestern New Brunswick, westerly and south to Georgian Bay in Ontario. Usually it occurs singly or in small groups. The nuts are edible and of fine quality but the shell is very hard and rough. There are some named selections of butternuts, such as Craxezy, Kinneyglen, Mandeville, and Johnson. Crosses between the butternut and the Japanese heartnut *(Juglans seiboldiana cordiformis)* have been made.

Black Walnut *(Juglans nigra)*

This species is native to the milder parts of Ontario in the counties bordering Lakes Ontario, Erie and St. Clair, and also extends over a wide range southwards of the Great Lakes in the United States. It can be grown as far north as Ottawa in sheltered locations. As a timber tree it is highly valued for fine furniture-making. The nuts are greatly esteemed by many people although too strongly flavored for some people's liking. While generally considered hard to crack there are some named selections which can be extracted without much difficulty.

Varieties of Black Walnut. Of the ten named varieties grown at the Horticultural Experiment Station, five have reached bearing age. Thomas has proven to be one of the best. The value of Ohio, Stabler, Ten Eyck and McCoy is in the order named. Ohio is a good grower, has a large, thick husk and comparatively small nut. Stabler is a poor grower and does not yield well. Ten Eyck and McCoy are moderately vigorous growers and hardy, but the nuts are only fair in size and crackability.

Persian Walnut *(Juglans regia)*

The Persian walnut is also known as English, French, Carpathian and Chinese. The exact country of origin is rather obscure. It is found growing wild in large areas of Asia and Europe from the Caspian Sea east to China and westwards through Caucasia to the Carpathian mountains in Eastern Europe. It has been very widely distributed in most European countries and also has been brought to North and South America (Chile). Most of the types of Persian walnut brought to the Eastern States and Canada have come via Italy, France, Spain and England, hence have not proven any too hardy. With the arrival of the Carpathian form of this nut from Poland and the Ukraine (see page 7 regarding introduction of these nuts by the Rev. Paul C. Crath) there is perhaps more prospect of obtaining seedlings well adapted to the North American climate.

Adaptability to our climate may not be simply a matter of withstanding low temperatures, but may be related to length of winter rest-period. If the rest period is comparatively short, and if it is easily broken by warm weather in early spring so that new growth starts, then, if freezing weather follows, severe injury may occur to the new shoots. This has been the experience in some seasons in eastern Tennessee, with the Carpathian walnut.

Varieties of Persian Walnut. Two varieties of French origin, Franquette and Mayette, are of little value in Ontario outside of the mild

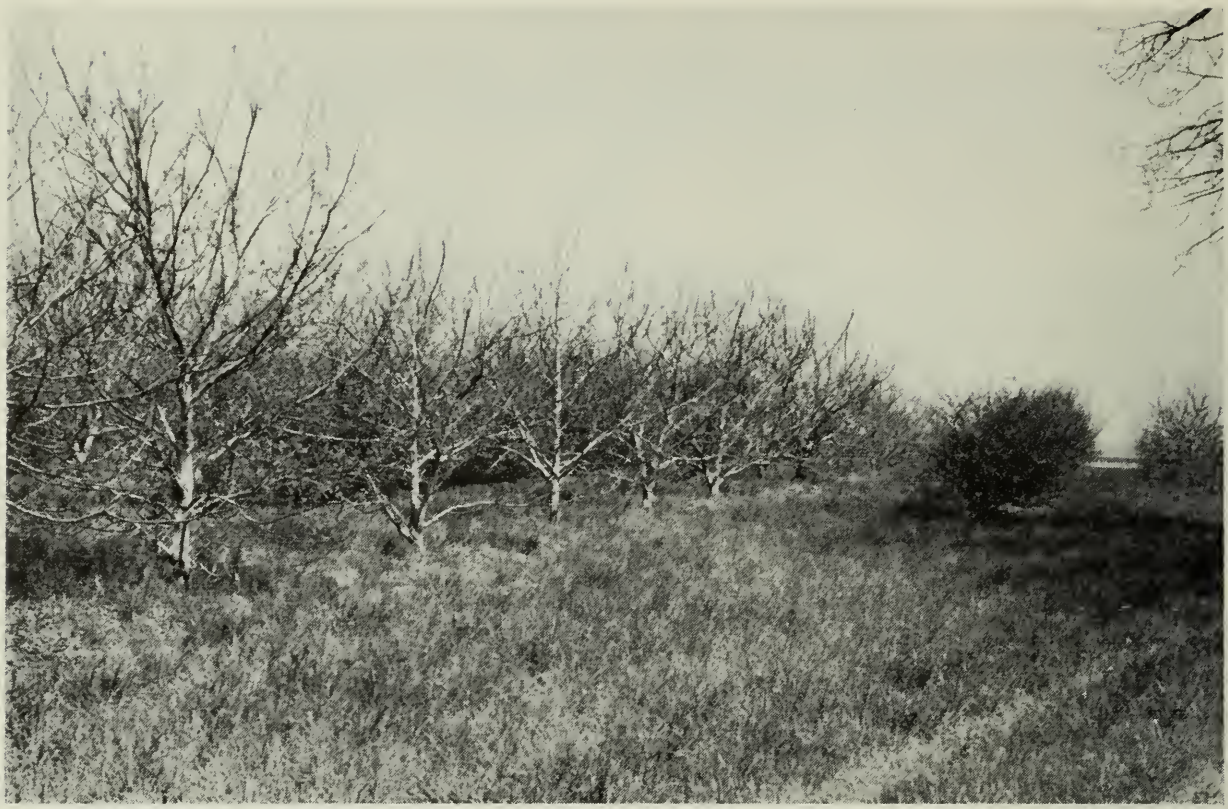


Fig. 2. Persian (English) walnuts in variety test orchard, Horticultural Experiment Station, in their fifteenth year. Row of filberts on right. This, and other Station nut orchards include many species and varieties of nuts (see page 7).

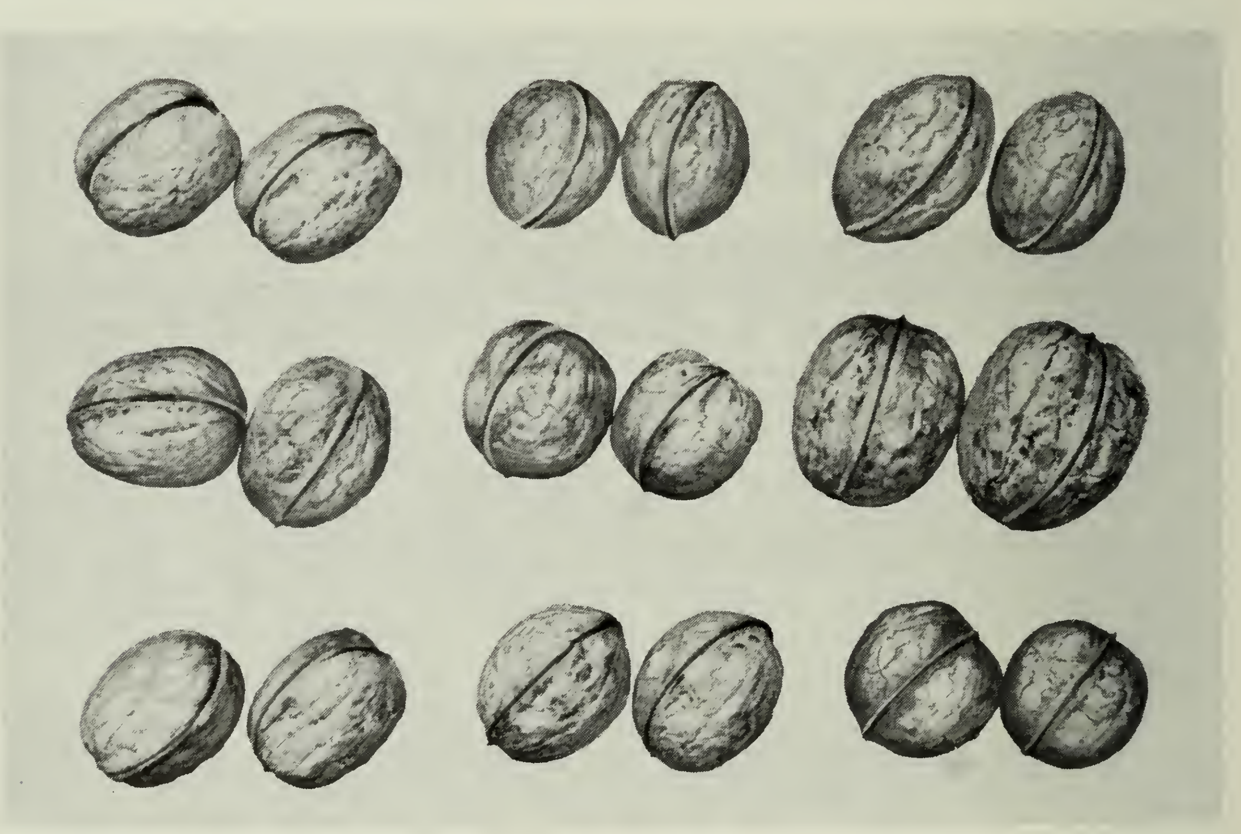


Fig. 3. Persian walnuts. Also variously known as English, French, Carpathian and Chinese. Shown above are specimens of three named varieties, and six numbered Station seedlings.

Top —Sdlgs. 13-14-2A, 13-3-14, and Franquette
Middle —Sdlgs. 13-4-6A, 13-2-3, and McDermid
Bottom—Sdlgs. 13-4-10A, 13-2-4, and Rush

Niagara District. They are grown extensively in California and Oregon.

The Hall variety is vigorous and moderately hardy. It usually yields well but the husk and shell are very thick and the kernel often fails to fill out properly. Rush is a less vigorous variety than Hall and is moderately hardy. It yields fairly well and the nuts are of medium size and of good quality. The husk and shell are thin and the kernel fills out well. Its chief weakness seems to be susceptibility to bacterial blight.

A named seedling, McDermid, from St. Catharines, makes good growth and is hardy. The nut is attractive although the shell is rather thick. The kernel comes out fairly easily and is fair to good in quality but the pellicle (skin of the kernel) is rather strong in flavour. McDermid appears to be only slightly susceptible to bacterial blight.

An open-pollinated Persian seedling, number 13-3-14, growing at the Horticultural Experiment Station, shows considerable promise although so far there is only one tree on which to base judgment. It has good vigour and seems to be reasonably hardy. The nut is rather long and oval similar to Franquette. It is smooth and attractive with a moderately thick husk and shell. The kernel is of fair to good quality, with a light-colored mild-flavored pellicle. Yield has been fair to good, depending on the season.

Fifty one-year-old seedlings of the Carpathian strain of Persian walnut were planted in 1937 at the Horticultural Experiment Station. All have been fruiting for several years, and fourteen of them have been given fair or better rating. The remaining seedlings show no particular promise, and normally would be discarded. However, they probably will be topworked with selected varieties and seedlings, and in this connection it is suggested that seedlings of this Carpathian strain might be very useful as rootstocks for other varieties of Persian walnut.

Several selections of the Carpathian walnuts have been named—Littlepage, Carpathian No. 1 and No. 2, and probably others. Another variety originated from seed which came originally from near Odessa in Southern Russia has been called the Broadview. This has been distributed by the Gellatly Nursery of Westbank, B.C. The Schaefer, from seed that came originally from Bukowina, is probably worthy of trial.

The Chinese form of *Juglans regia* has been tried for a number of years in the eastern part of the United States and Canada. The trees and nuts are similar in appearance to the other strains of *J. regia*. The nuts, however, are somewhat coarse and rougher, and have thicker shells; also the quality generally is inferior.

Japanese Walnut *(Juglans sieboldiana)*

This species is quite different to *J. regia* being somewhat like the butternut in appearance and bearing habit. The Japanese heartnut *(Juglans sieboldiana cordiformis)* is a variation of *J. sieboldiana*. It is a smooth-shelled nut and is heart-shaped as its name implies. It cracks in halves and the kernel comes out of the shell very readily. The flavour is pleasant and very mild.

Both of the above forms of *J. sieboldiana* are quick growers and make good ornamental trees. They are very susceptible to oyster-shell scale. Opinions differ as to their hardiness. However, they were badly injured at Guelph by the severe winter of 1933-34, when temperatures of —25°F. were experienced. There are several named sorts, such as Faust, Stranger, Ritchey and Gellatly.

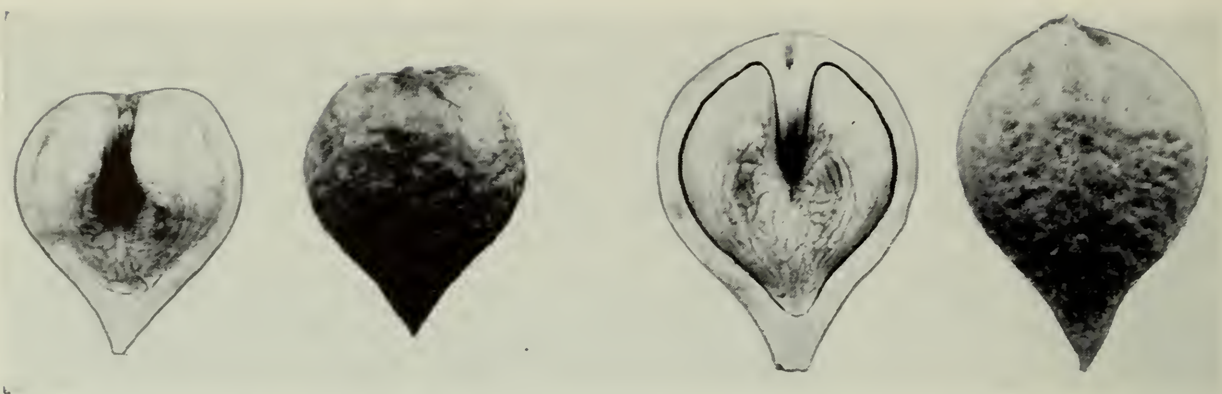


Fig. 4. Japanese heartnut. This is a form of Japanese walnut. (Juglans sieboldiana.)

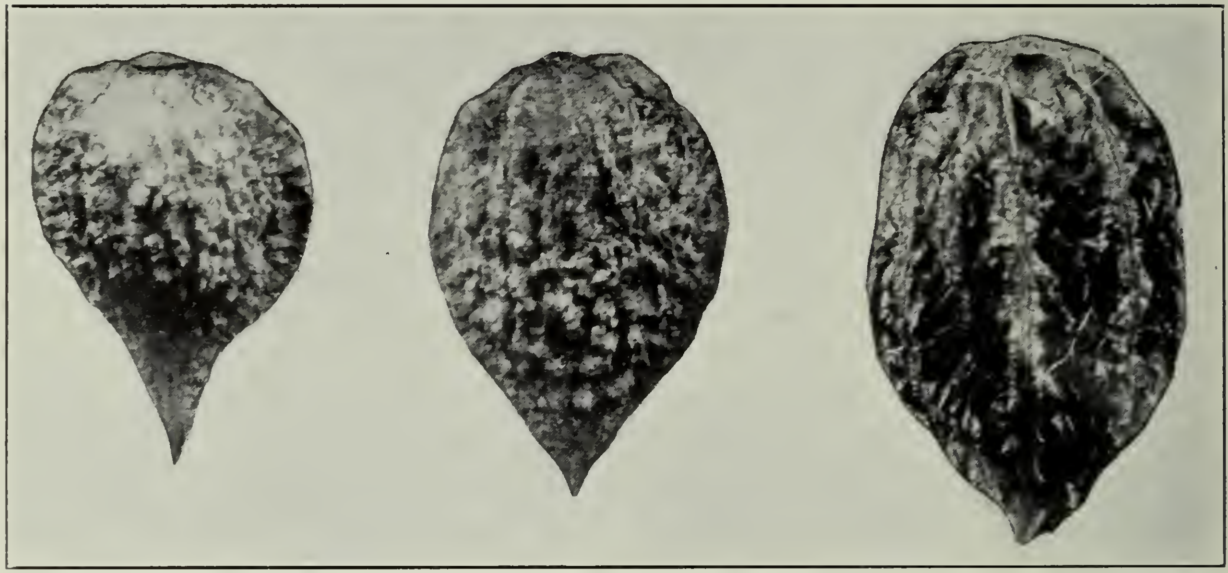


Fig. 5. Japanese walnut—butternut hybrids.

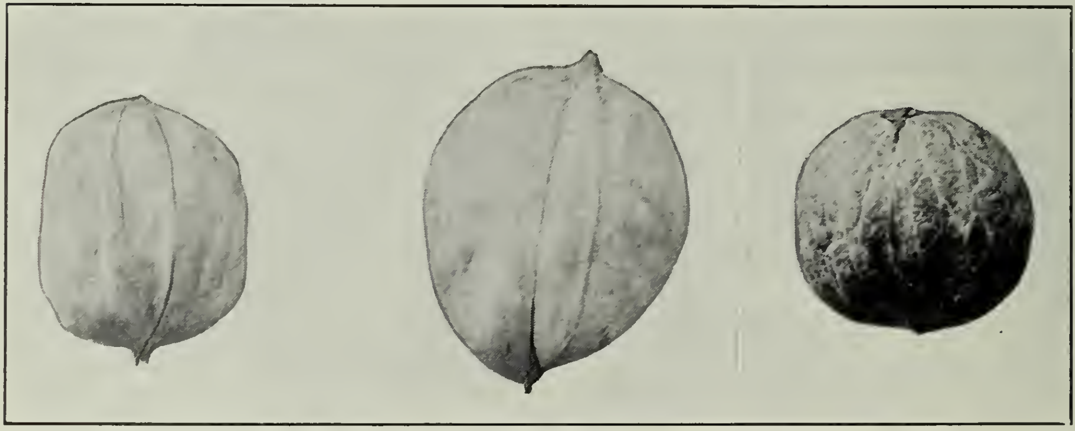


Fig. 6. Shagbark hickory. The single nut at the left is a probable shagbark—bitternut hybrid. The bitternut itself is a native hickory species, but of no value for food purposes.

Shagbark Hickory *(Carya ovata)*

The shagbark hickory is fairly widespread in Ontario, from the lower part of the Ottawa River to Lake Huron. Its wood is very tough and durable and is used for tool handles and machinery parts. The nuts are sweet and pleasant to the taste but the shells are hard and thick. Thus far the hickory is not planted for its nuts. There are several hybrids between the hickory and the pecan known as hicans.

Pecan *(Carya olivaeformis)*

This nut is a native of the United States and Mexico. It is found most abundantly in the region adjacent to the Gulf of Mexico but it extends northwards into Southern Indiana, Illinois and Iowa. It grows into a large tree where conditions are favorable. The more northerly forms are hardy in parts of Ontario not too far removed from the Great Lakes. Ontario, however, lacks the long, hot summer required for development of the nuts. The pecan crop of the south is obtained from the wild trees to some extent, but the planting of improved selections (named varieties) in large orchards has increased greatly, and the finer nuts of the commercial crop are from these orchards.

American Sweet Chestnut *(Castanea dentata)*

The native sweet chestnut, before the coming of the chestnut bark disease (blight) from the Orient, was one of the most important forest trees of North America, including the warmer parts of Ontario. The disease has practically wiped out this species, a double loss since the lumber was prized for interior trim in buildings, and the crop of nuts was quite an important item. At the present time, planting of this species is not recommended even if stocks were available, which is doubtful.

Chinese Chestnut *(Castanea mollissima)*

This species, a native of China, is more resistant to the bark disease than the American and European sweet chestnuts, and for this reason it was introduced into North America as a substitute for the native species. The many test plantings indicate generally high resistance, but resistance varies considerably with individual seedlings. Selection work is being done to find seedlings which combine resistance with other good tree-characters, including yield and quality of nuts.

The Chinese chestnut does not make a very large tree. It grows in a rather bushy form; also it is not as hardy as the native American chestnut. The nuts are not as large as our native species nor are they as sweet; however, there seem to be possibilities in breeding for resistance to blight and for improved nut and tree characters.

Japanese Chestnut *(Castanea crenata)*

This chestnut is reported to be somewhat resistant to the bark disease; also the nut is larger than the Chinese chestnut but of inferior quality. The tree is not as hardy as the native American species.

European Chestnut *(Castanea sativa)*

This is the species that grows so extensively in Western Europe. It is, however, susceptible to the bark disease, and recent reports indicate that much damage is being done in the chestnut forests of Italy.

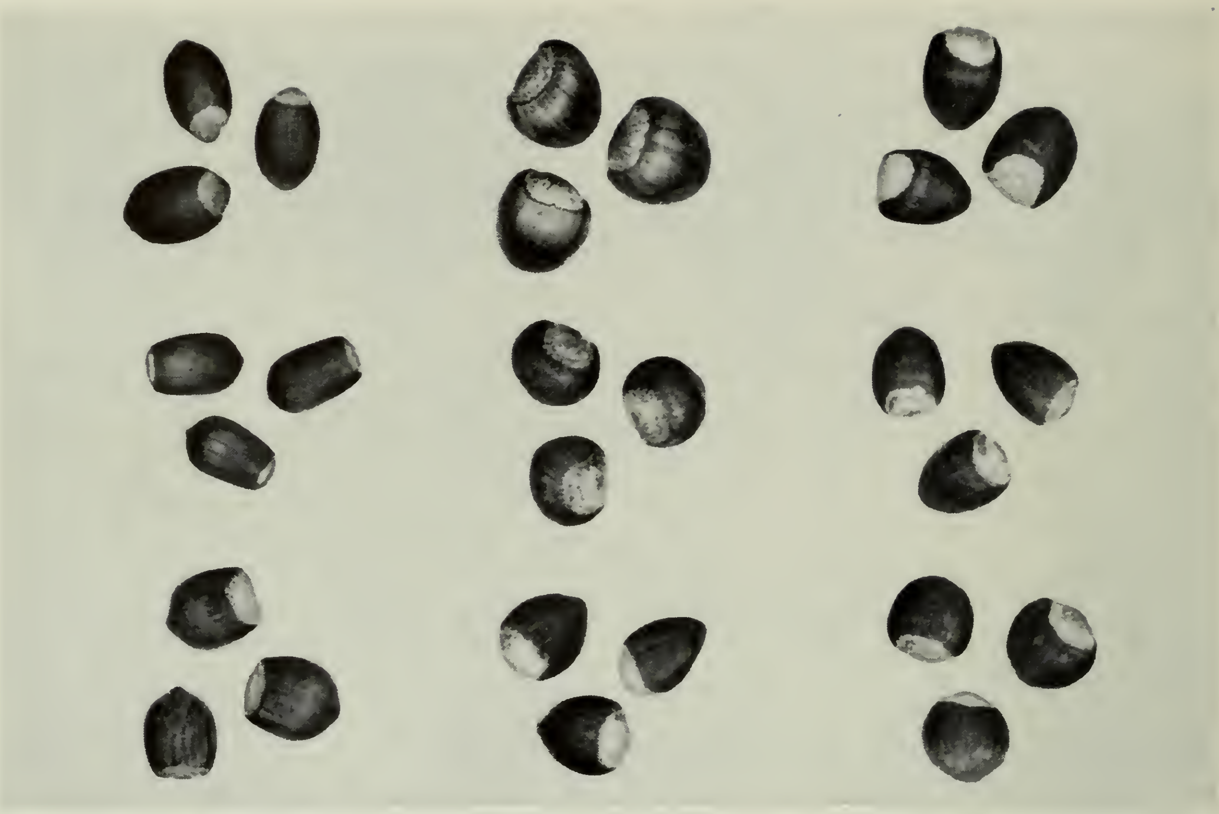


Fig. 7. Filbert-hazel hybrids may give hardiness to the filbert type of nut. All but two (*) of the above groups are such hybrids. Top—Geneva 555, Geneva 111, Bixby. Middle — 13-2A-46*, Geneva 159, Buchanan. Bottom — 13-3A-12*, Geneva 531, Jones Hybrid.

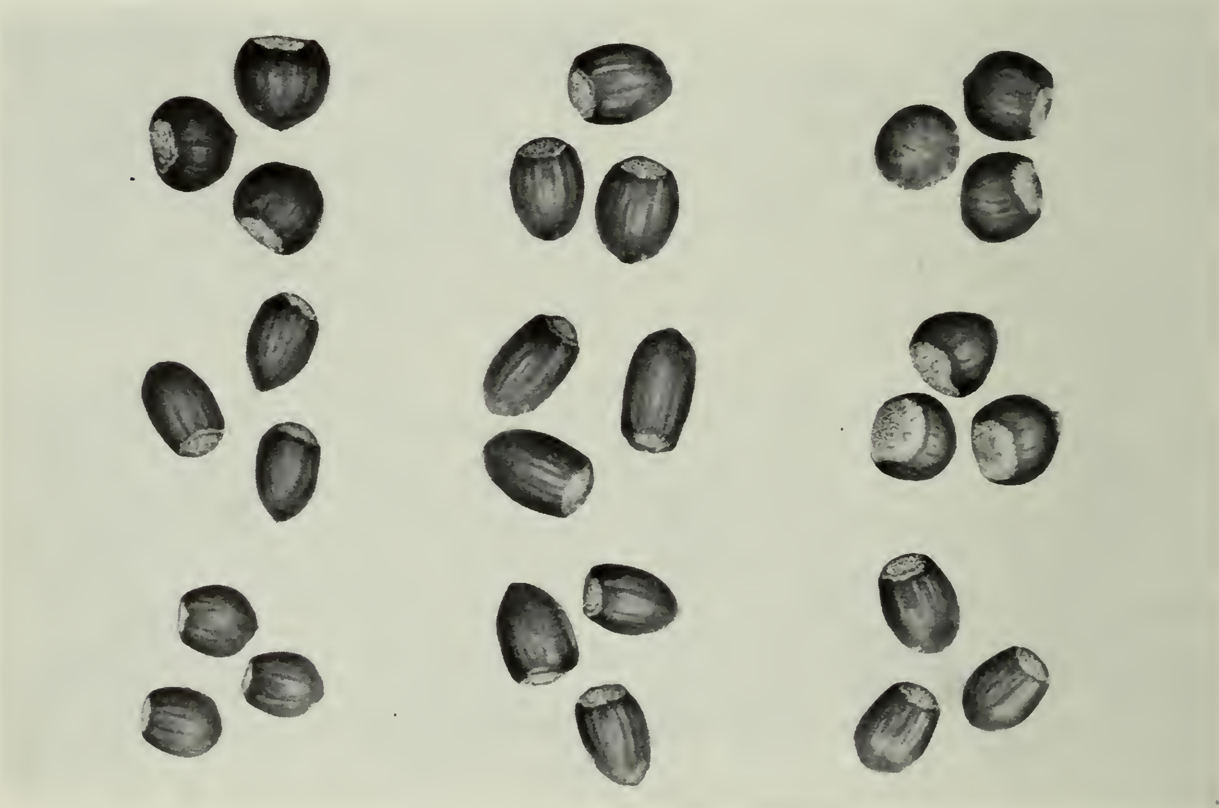


Fig. 8. Filberts do moderately well in southern Ontario, although not fully hardy, and uncertain as to crop. Station varieties include: Top—Luisen, Daviana, Barcelona. Middle — Medium Long, Du Chilly, Bollwyller. Bottom—White Aveline, Italian Red, Cosford.

American Hazel *(Corylus americana)*

Several selections, notably Rush and Winkler, have been made from this species. Crosses between these and the European filbert *(Corylus avellana)* have given rise to such hybrids as Bixby and Buchanan; also several Jones hybrids (originated by J. F. Jones, of Lancaster, Pennsylvania). On account of hardiness of catkin some of these would be useful as pollinators for European filberts.

Varieties of American Hazel. Rush, a selection made by J. G. Rush, of Lancaster, Pa., is a vigorous grower and produces a nut of larger size than the average American hazel. It is rather thick-shelled and has much fibre around the kernel. It may be useful where the filberts *(C. avellana)* of Europe are not hardy. Winkler, another selection of the American hazel, is reputed to have larger nuts than any other selection from this species.

The Bixby hybrid is a fairly vigorous grower, hardy in wood and catkin, and usually bears a good crop. It is late in ripening, about the first week of October. The husk clings tightly to the branch making it difficult to pick. The nut is medium in size, of good quality, and has very little fibre.

Buchanan, another hybrid, is much like the Bixby in plant characters, fully as hardy, but somewhat more vigorous. It usually yields fairly well and ripens 10 or 12 days earlier than the Bixby. It, too, is hard to pick and the nuts are not as bright as Bixby nor are they as large. The quality is good and there is practically no fibre.

The Jones hybrids are vigorous and hardy. However, the nuts have thick shells, there is much fibre around them, and they lack somewhat in quality.

Several of the Rush *(C. americana)* x filbert *(C. avellana)* hybrids in the Horticultural Experiment Station variety collection, and listed on page 9, show considerable promise. Particular mention may be made of No. 111 (Rush x Kentish Cob), No. 531 (Rush x Daviana), No. 555 (Rush x Du Chilly), No. 21 (Rush x Aveline), and No. 159 (Rush x Barcelona). These have been given good ratings on their performance at the Station for their first year or two of bearing, but they need to be tested for several years more before their value is definitely established.

European Filberts *(Corylus avellana)*

Filberts have been grown in Europe for very many years, and nuts were brought to the North American continent in the early days of settlement. For various reasons they have not become well established in the East as an orchard crop. They are, however, being successfully grown on the Pacific Coast, notably in Western Oregon and Washington where they have become an important commercial crop. Also, as previously stated, they are being grown to a limited extent in the mild coast country of British Columbia.

The chief difficulty with filberts in the Eastern States and Ontario is lack of hardiness in wood and catkin. Also, where prevalent, hazel blight may cause damage to the bushes.

Varieties of European Filberts. Barcelona. A strong, vigorous grower with rather spreading habit. It is moderately hardy, bears fairly consistently. The medium-size nuts are round in shape, and thick shelled. Quality is fair to good. The nuts mature early, about the first week of September, and they readily drop out of the husk. Another variety should be planted nearby as a pollinator. Barcelona is the main commercial filbert of the West Coast, with Du Chilly as a pollinator.

Beethe. This variety is of German origin. It appears to be hardy in wood and catkin. The bush is rather low-spreading. The nuts are medium to large in size and well-filled. However, it is not very productive. According to Mr. G. L. Slate of the Agricultural Experiment Station, Geneva, N.Y., Beethe is synonymous with Red Lambert.

Cosford. This is an old variety, long grown in England. It is a fairly vigorous grower and moderately hardy. The catkins are hardy and, as it blooms early, may make a suitable pollinator for Barcelona. The nuts are medium in size, of good quality, and have a thin shell with very little fibre. They ripen early and separate readily from the husk.

Daviana. A vigorous grower and hardy in wood. Catkins not always hardy. It has a large, attractive nut with a thin shell and very little fibre. The quality is moderately good. Nuts are usually borne singly, with a few pairs. Apt to cling to the husk.

Du Chilly or Kentish Cob. These varieties appear to be identical, although the two names persist. It is moderately hardy and is a fairly vigorous grower. On some bushes the yields have been quite poor. The nuts are enclosed by the long husk and in consequence do not separate readily. The shell is of moderate thickness and the nut has very little fibre. It is not always well-filled and is apt to shrivel on drying.

Italian Red. This is a moderately vigorous grower but not always hardy. The nut is large, attractive and of good quality. One of the best where hardy.

Luisen. This variety of German origin appears to be hardy in wood and catkin. It is not yet in full bearing at Vineland but appears to be promising.

Medium Long. A variety of German origin but of which the original name has been lost. It is a moderately vigorous grower and fairly consistent cropper. The nut resembles Cosford but is somewhat larger. It has a thin shell, usually fills well, and there is a moderate amount of fibre. The quality is good. It ripens a little later than Barcelona and is easy to husk.

SITES AND SOILS

It is sometimes stated that nut trees can be planted in places that cannot be used for other farm crops. This is only partially true, as it does not mean that they can be expected to thrive in low swampy places, nor on rocky hills, or poor, thin, eroded soils. Like most other crops they require a soil of reasonable fertility, adequate moisture, and good soil and air drainage. Also, the planting must be accessible to permit of spraying for control of insects and diseases, harvesting, etc.

As to location, while protection from strong cold winds is desirable, yet warm southern slopes, or the sunny side of buildings and warm pockets (which sometimes may also be frosty) should be avoided. These extra-warm locations have a tendency to force early growth of buds and catkins (pollen-bearing flowers) during unseasonably warm spells which, if followed by freezing temperatures, may cause much damage.

While the choice of soil for nut trees is often limited by what the land owner has available these soil preferences may be noted.

The butternut prefers moist, rich soil, but will grow satisfactorily in rocky soil of limestone formation.

The black walnut thrives best in deep, rich, moist soil.

The Persian walnut does best on neutral to slightly alkaline, deep, sandy-loam soils similar to those preferred for peaches and sweet cherries.

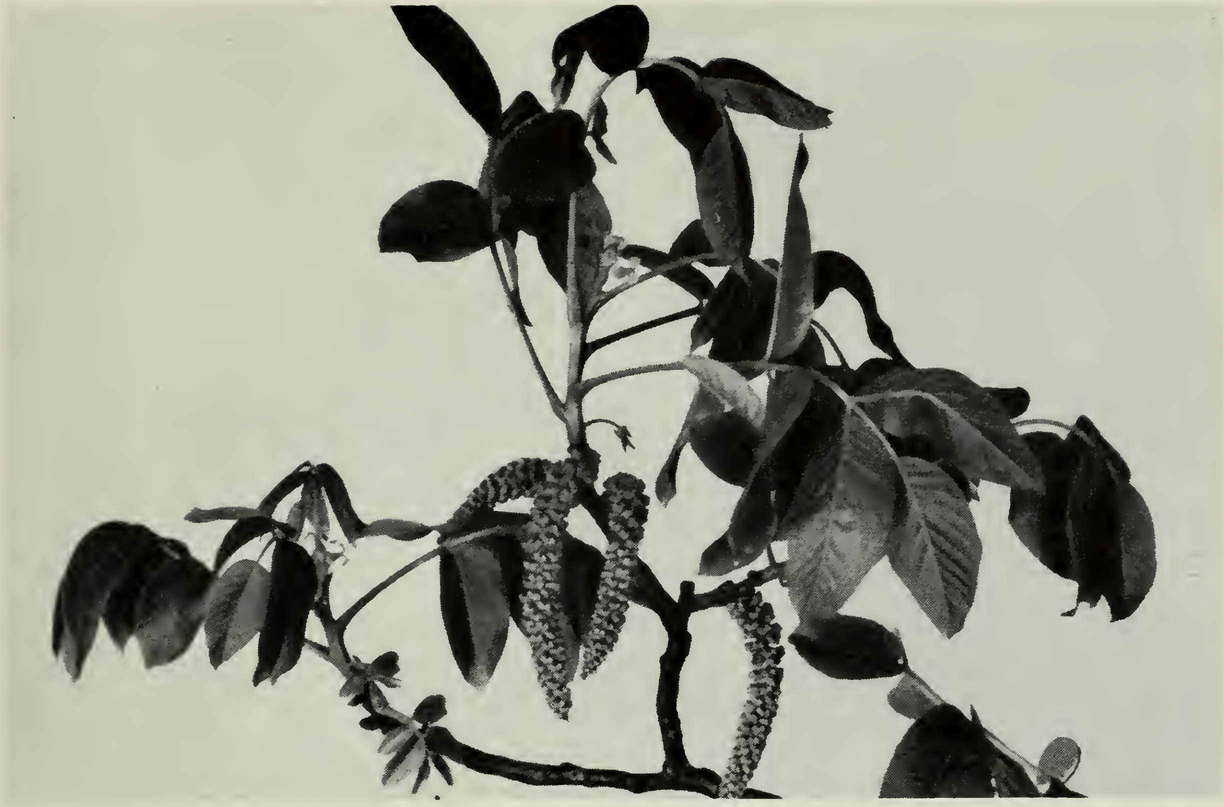


Fig. 9. The species of nuts grown in Ontario are monoecious, having one sex in one flower, the other in another, both on the same plant. Above, the drooping catkins (on Persian walnut) produce abundant pollen which, wind borne, pollinates the embryo nuts. These may be barely discerned at the apex of new growth, left and top centre.

The Japanese heartnut prefers a deep, fertile, well-drained, sandy loam.

Shagbark hickory. This species does best on a deep soil, moist, fertile, and well-drained.

The chestnut seems to prefer a good sandy-loam such as would be used for peaches and sweet cherries.

Filberts may not be particular as to soil although a deep, fertile soil is preferred. On poor, sandy soil the bushes will not thrive and the nuts will be small, while on wet, heavy soil the wood may not ripen well.

POLLINATION

In common with other catkin-bearing trees, nuts are wind-pollinated.

The necessity for cross-pollination in nuts has long been an open question but now it is definitely known that chestnuts and filberts require cross-pollination to ensure a good set. The safe practice with nuts, with the possible exception of the Japanese walnut and the butternut, is to plant at least two varieties together.

Self-sterility appears to be general in the filberts, so it is not advisable to plant out a solid block of one variety. A plantation should include *at least* two varieties, suitably interspersed. To further assure cross-pollination, it is better to plant in fairly compact blocks rather than in two or three long rows. This permits better distribution of pollen by wind.

The necessity for cross-pollination in filberts was well demonstrated at the Horticultural Experiment Station some years ago. Three bushes of one variety gave good yields of nuts during a period when several rows of other varieties were growing to the windward (west), and shedding lots of pollen.

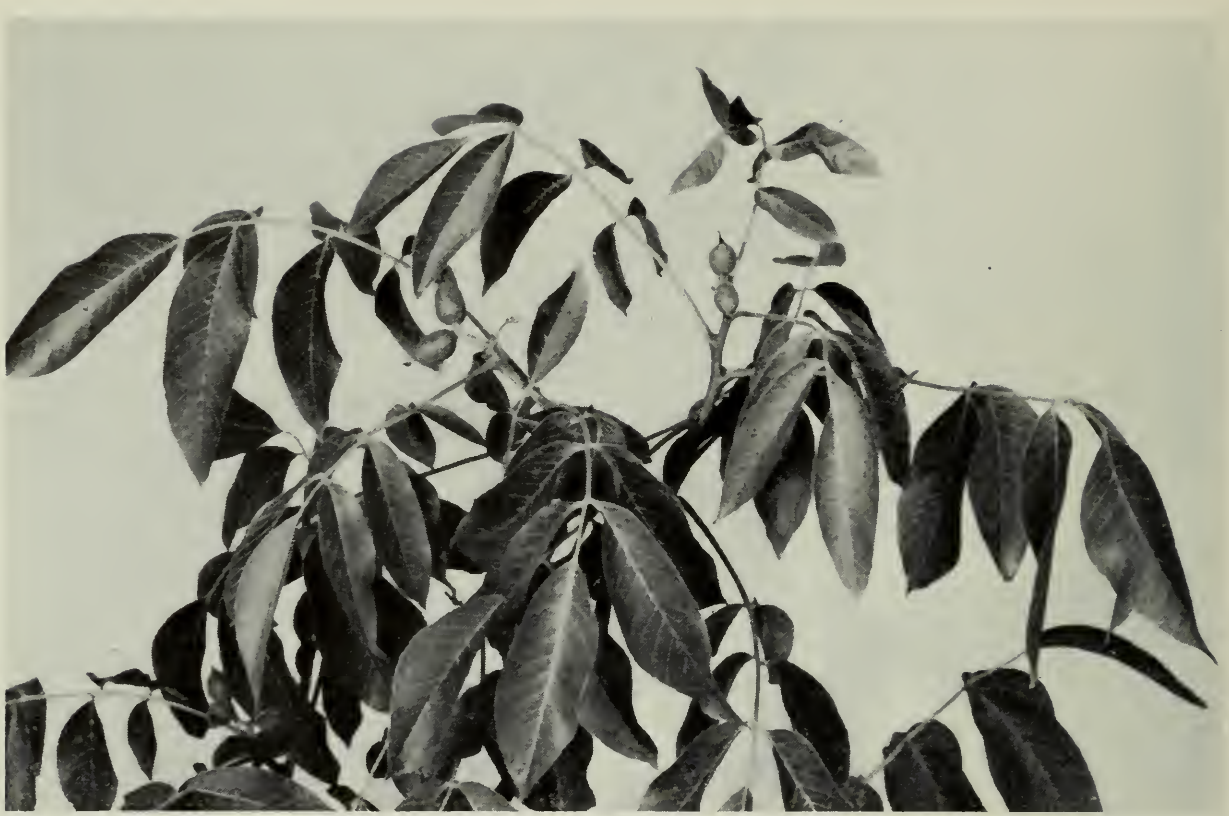


Fig. 10. Persian walnuts two weeks after pollination. The pollen-bearing catkins have dried up and fallen off.

When, however, most of the bushes in these windward rows were removed the crop on the three bushes decreased very markedly, so that now they yield only a very few nuts annually.

While the Persian walnut is not considered self-sterile, yet young trees may not bear, even when producing lots of female or pistillate flowers, because male or staminate flowers (catkins) are not produced until the trees are several years older. Hence, if young trees are set out near an older tree or trees already producing catkins, the young trees are likely to come into bearing earlier. As young Persian trees get older they will adequately pollinate themselves, even a single isolated tree.

Unfavorable weather conditions at pollination time may have a very adverse effect on the set of nuts; persistent, cold rains may ruin much pollen and also prevent it from being properly air-borne.

PROPAGATION

Seed

Where true-to-name varieties are not required nut trees may be propagated from seed; otherwise vegetative methods must be used.

Nut trees can be grown from seed by sowing them in a nursery row as soon as they are mature and before they get too dry or become moldy. If rats or squirrels are a problem, fall planting will not be practicable, and the nuts will have to be stored until spring.

Nuts may be held in a cool place over winter but the most satisfactory way is to stratify them in sand. This is done in the fall as soon as the nuts are mature. Layers of nuts are spread out in shallow boxes with layers of sand between them until the boxes are level full. These may be buried outdoors in a well-drained location, or they may be placed on top of the ground and completely covered with soil, peat, hay, straw, or other such material, and left there until spring. Protection from rodents should be provided by covering with wire netting. A very good type of box to use is one having a wire (about ¼-inch mesh) top and bottom. This affords both protection and drainage.

By spring the nuts will have germinated, and as soon as the ground is fit they may be set out, 8 or 10 inches apart, in nursery rows, covering them with 3 inches of soil,—filberts and chestnuts slightly less.

Layering

This method is used in propagating filberts. Some of the young shoots or suckers around the base of a bush may root to some extent and this can be encouraged by mounding with earth. When well-rooted, the shoots should be separated from the parent plant and set out in a new location.

Another way is to bend down young shoots, usually in August, and bury part of their length. The growing end, with several leaves, is left projecting beyond the buried part. Wooden pegs or heavy sods may be needed to hold the shoots in place. The young shoots should be rooted by late fall although a second season is sometimes necessary to get well-rooted plants. When well-rooted they are dug up, cut away from the parent plant, and set out in nursery rows. If single-stemmed rather than bushy plants are desired, care should be taken not to set filberts too deeply at any time as the buds on the buried part of the stem will grow and form suckers.

Budding and Grafting

Nut trees may be budded or grafted, using the same methods as for fruit trees generally. However, since a good "take" of buds or scions is more difficult with nuts some special techniques have been developed. Considerable detail attaches to some of these modified methods and the reader is referred to articles in various Reports of the Northern Nut Growers' Association, as given below.

Methods used include, in budding, the ordinary T bud, the patch bud, and annular or ring bud; and in grafting, a modified cleft graft, the splice graft, and the inlay graft.

Some propagators favour one method, others another. It is sufficient to say that extreme care is needed in making clean cuts, getting good fits of cambium with cambium, preventing drying of cut surfaces, making provision for drainage of excess sap, guarding against sun and wind injury, and using stock and scion of proper maturity.

Time is important in budding and grafting. Budding may be done in early spring when growth is starting, or during mid-summer; in any case, the bark should slip easily. Grafting is best done when the new growth is starting in the spring.

Grafting nuts in a greenhouse has often been more successful than outdoor grafting. Special methods are used but these are no more difficult than outdoor grafting. The details of one method, "Propagating Nut Trees Under Glass" is given in the 1946 Report of the NNGA. Other articles on nut propagation in NNGA Reports are:

Propagation of black walnuts through budding. S. Smith. 1943 Report.
What stock for heartnuts? J. Russell Smith. 1945 Report.
Propagation notes. Harry P. Burgart. 1945 Report.
Notes on nut tree grafting. E. M. Shelton. 1945 Report.
Experience with nut grafting. H. F. Stokes. 1945 Report.
Grafting methods adapted to nut trees. H. F. Stokes. 1946 Report.

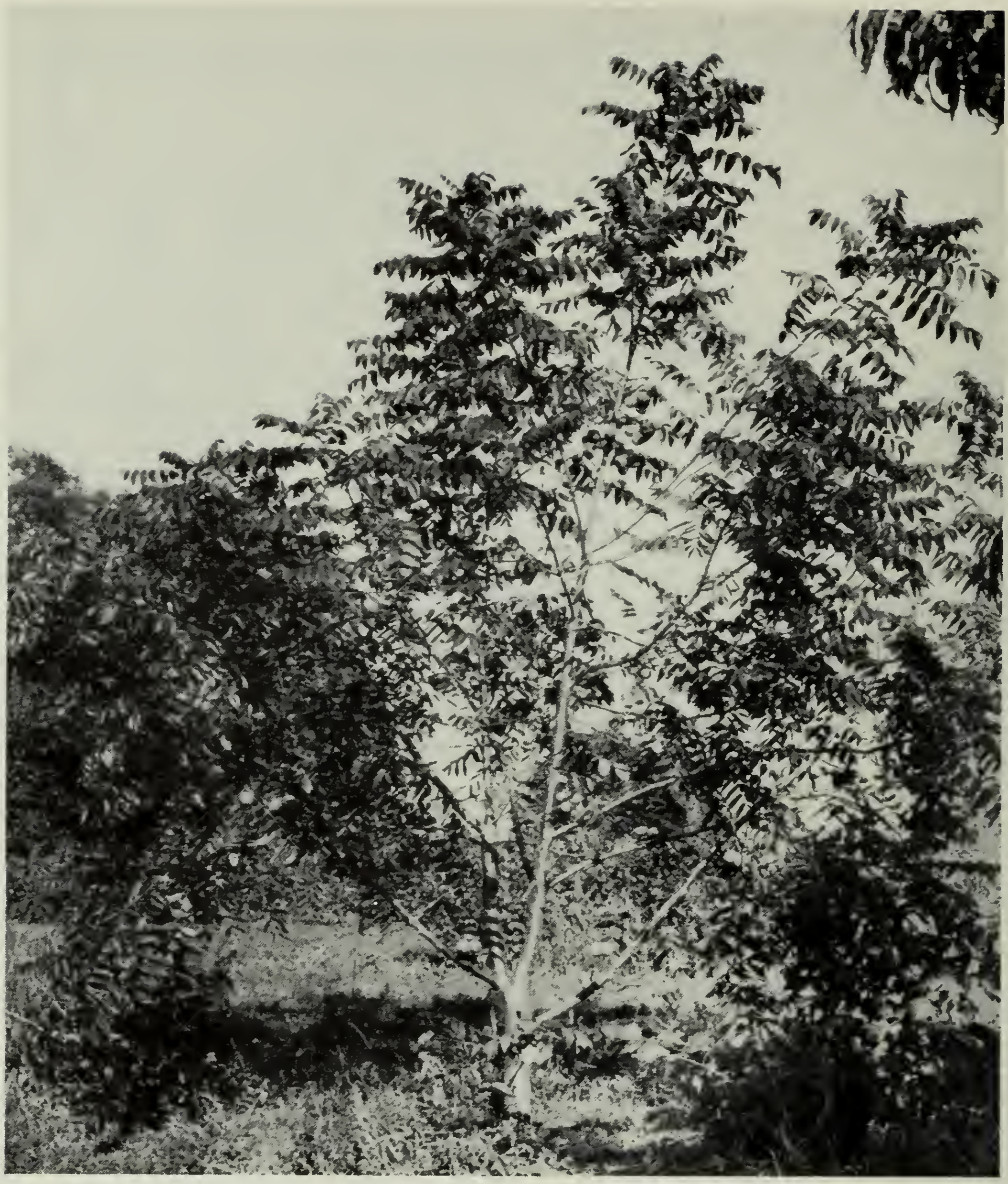


Fig. 11. Young grafted Persian walnut tree. As with our ordinary tree fruits, varieties (and superior seedlings) are propagated by budding and grafting. An exception is the filbert family which is propagated by layering.

Beginnings in walnut grafting. C. C. Lounsberry. 1946 Report.
Graft the Persian walnut high in Michigan. G. Becker. 1946 Report.
Budding walnuts. H. Lynn Tuttle. 1947 Report.
Stock-scion relationship. J. W. McKay. 1947 Report.
Propagation of Chinese chestnuts. Max B. Hardy. 1949 Report.

PLANTING

Careful handling of nut trees before planting is of great importance. On no account should the roots be left exposed to sun and wind. It is much better if trees can be replanted as soon as they are dug. If coming from a distance and planting has to be delayed, the trees should be heeled in, or the roots otherwise well protected from drying out.

The depth of planting is important. This is usually the same depth as previously grown in the nursery row, or slightly deeper. Sometimes with filberts, as noted on page 21, it is advisable to avoid planting too deeply.

Nut trees are more difficult to transplant successfully than fruit trees generally, and therefore require even more care in planting. A hole should be dug somewhat larger than the spread of the roots, and 4 to 5 inches deeper than required. Place several inches of good top soil in first, and firm it down. If the available top soil is poor it is advisable to mix it with some peat or *thoroughly rotted* manure. This will help to hold moisture in a sandy soil, and make a clay soil more open.

The tree is then held in place with the roots carefully spread out, and good earth placed amongst them and firmed down with the foot or a blunt stick. The latter is preferable at first, as it can be used to push the earth in between the roots and pack it firmly. Gradually fill and firm, until about 3 inches from the top. Then if the soil is dry, water well. This ensures moisture for the tree, also helps to consolidate the soil and keep the tree in place. It also fills air pockets in the soil. Allow the water to soak away before completing the filling, then cover the space around the tree with a mulch of strawy manure, hay, peat, or similar material. This mulch helps to check loss of moisture by evaporation, and keeps the soil cool.

PRUNING

While nut trees may not need much pruning, yet it is not wise to neglect it. Shape the tree at planting time by removing badly placed branches and shortening others. Pruning at this time also helps to counteract transplanting shock.

After the initial pruning very little more, if any, will be necessary during the first few years of the tree's life. The aim should be to watch the growth and placement of branches and remove the occasional one which crowds its neighbors. If this is done consistently, no heavy pruning will be required at any time.

If filberts are to be grown to a single stem it is advisable to rub off at planting time any buds or sprouts on the portion of the stem that will be below ground level when planted. This will help considerably in controlling sucker formation. If a single stem is thought to be a disadvantage by reason of sun scald in winter, then several of the strongest suckers may be allowed to develop into stems, which should themselves be kept free of further suckering or the whole bush will soon grow into a thicket requiring considerable thinning out.

TILLAGE, SOD MULCH, FERTILIZERS

Except for a planting-time mulch around newly set trees it is best to cultivate the soil for three or four years, or until the young trees are well established. Thereafter they may be grown under a sod-mulch system. If the trees are set in sod they must receive better than average care, with particular attention to maintenance of a good mulch about three feet in diameter.

The mulched area, under a sod system, should be increased as the trees develop. It should extend to or beyond the spread of the branches.

Some nitrogen, especially under sod-mulch conditions, may be needed to help the young trees along. Apply a year or two after planting or when the trees have become established, and annually thereafter as needed to maintain good growth. Ammonium nitrate (or its equivalent) may be used, the amount varying with the age and condition of the tree. One-eighth pound of ammonium nitrate for each year of the age of the tree is a general recommendation.

In addition, and especially if the soil is generally low in fertility, a fertility-building and maintaining fertilizer may be used. A 5-10-13 is recommended, 500 pounds per acre. Liming of acid soils will help English walnuts.

HARVESTING

Nuts are normally, and best, left to ripen on the tree and fall to the ground from where they are gathered up and cleaned ready for immediate use or storage. Nuts on the same tree do not all ripen together and of course there are seasonal differences between varieties as well, so that harvesting is likely to be extended over several weeks.

There is also a great difference in the way Persian walnuts, filberts, and chestnuts separate from the husks. Some Persian walnuts separate very readily and the clean nuts fall to the ground. In other Persian varieties the husks may be very slow in splitting or, with some seedlings, may hardly split at all. Such nuts likely will have to be picked, and the husks stripped off by hand. A similar situation occurs in filberts. In some, the nuts separate from the husk very freely and drop to the ground; e.g., the Barcelona variety, where the husk is short and open. In some varieties the nuts are held tightly as in Du Chilly which has a long, close-fitting husk. Ease of separation of nut and husk makes a considerable difference in the labour of harvesting. It should be given consideration when choosing varieties to plant.

It is important that nuts be cleaned promptly after gathering. This is particularly so with the Persian walnut as the shell becomes stained very quickly if left in the husk, and this of course spoils its appearance.

YIELDS

Few careful yield records have been kept of nut trees in Ontario. Perhaps one of the most notable features relating to yields of Persian walnuts in Ontario is their inconsistency. For a year or two a tree may have good crops, then for several years give only light crops, and so on. Filberts, too, are somewhat variable, though perhaps less so than Persian walnuts. Black walnuts and chestnuts vary too, from year to year. This condition, of course, applies to the common tree fruits to some extent and is partially accounted for by the habit of biennial bearing in some varieties. However, weather conditions at certain critical periods would seem to be of particular importance with nuts. Until varieties are found that are really "at home" in the Ontario climate this inconsistency of yield is likely to remain a serious factor in the home production of nuts.

PESTS

Various pests may cause considerable trouble. Some insects may chew the leaves (e.g. walnut caterpillar) or get into the husks and nuts, while still others such as aphids, and scale insects (on Japanese walnuts), may suck the sap out of the leaves and stems.

Diseases have caused very serious loss, notably the chestnut blight or bark disease which has destroyed most of the native chestnut forests of Eastern North America and is now destroying many of the chestnut trees of Italy. There seems to be no control of this disease except breeding for resistance. The Chinese chestnut *(Castanea mollissima)* is resistant to it and is being used in selection and breeding experiments by the U.S. Dept. of Agriculture and by State Experiment Stations.

Filbert blight may cause serious loss among filbert bushes. It appears on the infected branches as wart-like excrescences about ⅓-inch long. In time it kills the branch and eventually destroys the whole plant. There seems to be no cure. The disease is common on native hazels but does not seem to have much effect on them.

Walnut blight or bacteriosis can be a very serious trouble on the English walnuts. It appears as black, dead spots on green shoots, leaves and nuts. Many nuts fall prematurely but others reach full size, with husk, shell, and kernel more or less blackened and destroyed. It over-winters in mummified nuts or in the buds. Control consists of spraying with Bordeaux 12-6-100 just before female blossoms open. These will be observed on the ends of new shoots. If this spray causes burning, and if aphids are troublesome, try a low-lime Bordeaux 4-2-100, plus an oil emulsion 1 pt. to 100 gal. Apply two or three times before blossoms open.

Blue jays and grey squirrels may get the greater part of the filbert crop unless steps are taken to combat them. Avoid planting filberts anywhere near the natural shelter of these two pests. They both start their depredations while the nuts are still green, especially the jays.

Perhaps it is hardly fair to include humans along with the pests. They can, however, be very troublesome. A nut plantation, or maybe a single tree, is apt to become the target for every nut-minded boy or girl in the neighborhood. Even a passing motorist may consider a nut tree fair game, not that the nut grower would begrudge anyone a few nuts, but wholesale pilfering is a different matter.

ACKNOWLEDGMENTS

This bulletin is based to some extent on the writer's experience over the past thirty years with nut crops at the Horticultural Experiment Station. A considerable portion, however, is compiled from the writings of, and correspondence with, other workers. In particular should be noted the bulletins by Dr. L. H. MacDaniels of Cornell University; Mr. G. H. Slate of the Agr. Exp. Station at Geneva, N.Y., and Mr. G. Balcom, College of Agriculture, University of California. A long letter from Rev. Paul C. Crath, of Toronto, gave an interesting account of his introduction of the Crath Carpathian walnuts.

The annual reports of the Northern Nut Growers' Association have been a source of much information. A little book entitled Nut Growers' Handbook, by Carroll D. Bush (General Publishing Co., Toronto), although written from the Pacific Coast growers' viewpoint, provided much of interest and value on practical nut growing.